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WORLD AQUACULTURE SAFARI 2025

June 24-27, 2025

Speke Resort, Munyonyo, Entebbe, Uganda

**International Conference and Exposition of
World Aquaculture Society and African Chapter, WAS
Conference Includes AFRAQ 2025**

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Welcome to World Aquaculture Safari 2025

Dear Colleagues and Friends,

Welcome to Entebbe, Uganda, and the World Aquaculture Safari 2025 Conference (WA25 Uganda)! On behalf of the WAS Board of Directors, I invite you to enjoy WA25 Uganda at the magnificent Speke Resort Munyonyo - a world-class conference and exhibition facility on the shoreline of Lake Victoria.

This marks the second time a WAS global event has been hosted on African soil, following the successful World Aquaculture 2017 conference in Cape Town, South Africa. Since 2022, WAS has successfully hosted the Annual Aquaculture Africa Conferences (AFRAQs) in Egypt (2022), Zambia (2023), and Tunisia (2024). This is clear evidence of the WAS African Chapter (WAS AC)'s ability to grow stronger as Africa's premier aquaculture forum, bringing together major stakeholders from industry, government, international organizations, academia, and research communities.

The successful establishment of the WAS AC and AFRAQ events reflects the rapid growth of the African aquaculture sector and the need for stakeholders to have an annual forum for reviewing progress, networking, generating new ideas, and advancing the development agenda. Africa is the last continent to develop its aquaculture sector, but the growing deficit in overall fish production is driving a boom in production. Nonetheless, the continent still faces many challenges in its quest to realize its full potential.

It is fitting to bring WA25 to Uganda, Africa's third-largest aquaculture producer by volume. The WAS community has much to learn from Uganda's approach to aquaculture value chain development, particularly regarding micro, small, and medium enterprises (MSMEs), supported by enabling policies and active institutions. These factors have contributed to building a sector poised to enhance food and nutrition security, create employment, improve livelihoods, and drive economic growth. We believe that fellow African countries can draw valuable lessons from this great nation.

I would like to commend and thank the conference organizers, along with members of the Steering, Program, and National Organizing Committees, who have worked diligently to plan, coordinate, and bring together the technical program, trade show, and associated meetings. To our sponsors and partners, thank you for supporting Africa's sustainable aquaculture development journey. WA25 Uganda was made possible through the EU-funded TRUEFISH Project, implemented by the Lake Victoria Fisheries Organization.

A special thank you goes to our host, the Government of the Republic of Uganda (Ministry of Agriculture, Animal Industry and Fisheries), and its associated agencies for welcoming us to this great aquaculture and tourism-friendly nation. I hope that all the positive elements of this event will contribute to further transformation of the sector and elevate it to even greater heights!

Thank you to all participants for joining us to make WA25 Uganda a memorable event. Next year in December, we hope to convene again in Eastern Africa, in Tanzania, for the World Aquaculture Tanzania 2026. I look forward to meeting many of you there!

I believe there is something for everyone at WA25 Uganda. Enjoy every moment, including all that this wonderful country has to offer!

Foluke O. Areola
President: World Aquaculture Society (African Chapter)

John K. Walakira
Co-Chair: WA25 Uganda

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ABSTRACTS

EXPLORING THE GENETIC DIVERSITY AND POPULATION STRUCTURE OF NILE TILAPIA *Oreochromis niloticus* TO ADVANCE SELECTIVE BREEDING IN UGANDA

Ivan Abaho*, Gerald Kwikiriza, Papius D. Tibihika, Andrew A. Izaara, Faith Atukwatse, Timothy Omara, Juliet K. Nattabi, Nasser Kasozi, Manuel Curto, Andreas Melcher, and Harald Meimberg

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The development of a selective breeding program for Nile tilapia (*Oreochromis niloticus*) in Uganda holds significant potential for enhancing aquaculture productivity. However, the genetic diversity of the species remains inadequately characterized, hampering the establishment of a systematic breeding program, and consequently adversely affecting the production of Nile tilapia. Therefore, the present study explored the genetic diversity and population differentiation among farmed and wild Nile tilapia populations to contribute key insights for designing a systematic breeding program in Uganda. A total of 480 samples from 20 populations, including farmed and wild populations, were collected across Uganda. Microsatellite markers were used for genotyping, and genetic diversity indices, including heterozygosity and FST values, were analyzed. The study employed hierarchical clustering and population structure modeling to assess genetic differentiation. Results indicated that expected heterozygosity (0.50 ± 0.01) was higher than observed heterozygosity (0.42 ± 0.01) in all populations, although the differences were not significantly different. Populations from pond farms exhibited lower FST values (<0.001), suggesting minimal genetic differentiation. The hierarchical clustering identified four major genetic clusters: 1) cage populations (Pal and Busana), 2) Katosi, SON, and Rocks hatchery, 3) Bawe cage fish farm and Tendo hatchery, and 4) populations from ponds and beaches on Lake Victoria. The Tendo and Rocks populations demonstrated higher genetic diversity and differentiation, making them potential candidates for selective breeding efforts. These findings contribute crucial information for the conservation of Nile tilapia genetic resources and support the establishment of a selective breeding program in Uganda.

ASSESSMENT OF EFFICACIES OF 17α METHYL TESTOSTERONE HORMONE AND SOME SELECTED ESTROGENIC PLANTS EXTRACTS ON THE GROWTH AND SEX REVERSAL OF NEWLY HATCHED *Oreochromis niloticus* (TILAPIA) (LINNAEUS, 1758)

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The 17α-methyltestosterone is the most common synthetic hormone used in male mono-sex production of Nile tilapia, *Oreochromisniloticus*. The current study was aimed at finding out the efficacies of 17α methyl testosterone hormone,*Carica papaya* (pawpaw) and *Moringaoleifera*(Moringa) seed extracts and *Mangiferaindica* (Mango) leaves extracts on the sex reversal of newly hatched *oreochromisniloticus*(Tilapia) for a period of sixty (60) days.A total of 600 fry were randomly allocated to 24 experimental ponds.The hormonal diets were formulated by adding 17α- methyl-testosterone (Tc), *Caricapapaya*seeds extracted with methane (T1), *Caricapapaya*seeds extracted with hexane (T2), *Moringaoleifera* seeds extracted with methane (T3) *Moringaoleifera* seeds extracted with hexane (T4) *Mangiferaindica*leavesextracted with methane (T5), *Mangiferaindica*leaves extracted with hexane (T6) and basal feed with neither hormone nor plant extracts as negative control (T7) at an inclusion of 40ml/ kg diet on the treatments.

The fry were fed at 20% body weight during a 30 day feeding trial and a gradual reduction of feed to 10% during the second months rearing period. Results of the growth parameters showed highest weight value of (7.66±0.00 g) in T2 followed by (7.19±0.00g) in T1, the lowest mean weight value of (5.06±0.01g) was observed in negative control group T7. The maximum length value was recorded as 10.77±0.01 cm in T1, followed by 10.56±0.01cm in T2, followed by 9.96±0.00 cm in TC (positive control). The lowest length value was recorded as 6.99±0.01cm in T7 (negative control).The highest value of SGR (%) occurred at (11.07) from T2 followed by T1 (10.96) and T7 recorded the lowest SGR with (10.37). The maximum survival rate (97.88±2.25) was observed in the negative control group (T7), survival rate of 95.79±3.29 was observed in TC (positive control) and (96.50±2.26) in T1. However, there were no significant differences (p>0.05) in the survival rates among the treatment groups. The results of the physicochemical parameters showed no significant differences (p>0.05) among all the treatments and the results were within the recommended ranges for the growth and survival of *O. niloticus*(Table 2).Results from the gonad examination (Table 3) revealed that Nile tilapia fry fed with 17α methyl testosterone hormone diet (Tc) produced the highest phenotypic males of 87%, while T1,T2,T3, T4, T5, T6 gave males of 80%,77%,73%,69%,60%,63% and 27% respectively.

Further studies are required to understand the exact mechanism through which the Pawpaw and Moringa seeds and Mango leaves exert their effect of sex differentiation innewly hatched *O. niloticus.*

Table 2: Water Quality Parameters during the treatment Period of 60 days

Month / week	Temperature (^{0}C)	pH	Dissolved Oxygen (mg/l)
First week	27.43±0.51^a	7.17±0.29^a	5.26±0.19^a
Mar	27.53±0.50^a	7.56±0.17^a	5.34±0.32^a
Apr	27.90±0.17^a	7.20±0.35^a	5.57±0.12^a

Table3:The Male and Female Sex ratio in *O. niloticus*after 60 days treatment

Treatment	% Male	%Female	M:F Ratio
Tc	87	23	3.8:1
T1	80	20	4.0:1
T2	77	23	3.3:1

SELECTIVE BREEDING STRATEGY FOR ENHANCED GENETIC DIVERSITY FOR TILAPIA (*Oreochromis niloticus*) PRODUCTION IN KENYA

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Nile Tilapia (*Oreochromis niloticus*) is a vital aquaculture species in Kenya, contributing significantly to food security and economic development. However, reduced genetic diversity and inbreeding depression have led to suboptimal growth performance and productivity in farmed stocks. This study explores the impact of selective breeding on genetic enhancement and productivity improvement in farmed tilapia populations. Through a structured breeding program incorporating genetic assessments, controlled breeding strategies, and performance evaluations, we aim to enhance growth rates, disease resistance, and adaptability to local aquaculture conditions. Both on-farm growth trials and molecular approaches were used to validate the impact of selection on the Sagana Strain. Sagana strain (SAG-F8) produced through selective breeding, super YY strain (KAM YY) from Kamuthanga fish farm and the local strain (LOC-T) obtained from Siaya county were exposed to growth performance trials. The fish were fed 35% crude protein diet for 180 days at Bukani Aquapark. For molecular approaches, Polymerase chain reaction (PCR) was used to amplify DNA with nine microsatellite DNA markers designed for *O. niloticus.* Genetic diversity was quantified using several different parameters, including the average number of alleles per locus (A), the total number of alleles per population (NA), the number of effective alleles per population (AE), allelic richness (AR), observed heterozygosity (H_O), expected heterozygosity or gene diversity (H_E), and fixation index (FST).

There was no significant difference in terms of mean weight gain (MWG) between SAG- F8 and LOC-T strain exhibiting 159.786±6.76 g and 158.623±4.67 respectively. However, under similar conditions, the KAM-YY strain had a significantly lower MWG compared to the two strains. Food conversion ratio (FCR), specific growth rate (SGR) did no demonstrate any significant difference amongst the different strains. The trend is confirmed in genetic diversity assessment results where, the Sagana strain exhibited a higher genetic variability than all the other farmed strains. The highest allele richness was observed in fish samples from KMFRI Sagana Centre, with a mean of 7.625 alleles per locus, the lowest *H*□ was recorded in the Victory Farm population (0.625). The findings underscore the importance of genetic management in aquaculture and provide a roadmap for implementing large-scale breeding programs to enhance the resilience and productivity of tilapia farming in Kenya.

MULTIVARIATE ANALYSES OF WATER QUALITY INDICES AND INCIDENCE OF *Aeromonas* species IN WATER FROM DIFFERENT HOLDING FACILITIES IN TROPICAL CONDITIONS

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Understanding the interactions between physiochemical parameters and pathogenic microorganisms is critical in maintaining the health status of fish farms. This study evaluated the impact and correlation of physiochemical parameters of water from various culture environments on the prevalence of *Aeromonas* species. The physicochemical parameters of water samples obtained from 36 farms, which included earthen ponds, plastic tanks, and concrete tanks were analysed. The isolated *Aeromonas* species were further characterised biochemically and molecularly through the 16s rRNA polymerase chain reaction. The monthly count of the presumptive *Aeromonas* species varied from the different culture facilities and ranged between the least value of $0.2 \pm 0.1 \times 10^1$ observed in plastic tanks and the highest value of $7.2 \pm 0.1 \times 10^5$ CFU per 100 ml in earthen ponds and was significantly different at $P < 0.05$. There were variations in each of the assessed physicochemical parameters of the water from the fish farms. Except for ammonia, nitrite, and biochemical oxygen demand in concrete ponds and plastic tanks, all the parameters exhibited a positive correlation with each other. The relationship between the parameters and *Aeromonas* species across the various culture facilities showed positive correlations with pH, dissolved oxygen, nitrite, and biochemical oxygen demand, conversely, temperature, nitrate, carbon dioxide, chemical oxygen demand, and ammonia showed a negative association that influenced the prevalence of *Aeromonas* species. Monitoring water quality parameters plays an important role in minimizing the incidence of disease, and sustaining the growth and survival of fish in fish farms.

ASSESSMENT OF HOUSEHOLD LIVELIHOOD DIVERSIFICATION AND FISHERIES CONSERVATION STRATEGIES AMONG FISHERMEN IN COASTAL AREAS OF OGUN STATE, NIGERIA

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This study assessed the association between household livelihood diversification and fisheries conservation policies among fishermen in coastal areas of Ogun State, Nigeria by adopting a multistage sampling procedure. The sample size was 90 fishermen from six randomly selected fishing communities (Abureji, Agbalegiyo, Ilamo, Imosan, Iseku and Wharf) along the coastline in Ogun State, Nigeria. Data were collected using pre-validated interview schedule and subjected to descriptive and inferential analytical techniques. Results revealed that majority of the fishermen were married (98.9%), in the age bracket of 41-60 years (71.1%) with mean age of 49 years, had household size of 6-15 persons (91.1%) with mean household size being 9 persons, from extended families (90.0%), either either no formal (43.3%) or only primary education (41.1%), were non-members of social groups (62.2%), and had no other occupations (93.3%).

It was also reported that there was generally low level of household livelihood diversification across the fishing communities. Gill nets were the most commonly used fishing gears across the fishing communities (80.0%). This was followed by seine nets (63.3%), traps (56.7%) and trawl nets (53.3%) while fish aggregating devices (35.6%), cast nets (37.8%) and hook and line (24.4%) were the least used fishing gears in the study locations. Results further revealed that coastal fishery was characterised by conflicts among water users (64.4%), absence of protected fishing areas (81.1%), and experience of water pollution (36.7%). Majority (71.1%) of the fishermen across the study locations agreed with closed season policy as a coastal fisheries conservation strategy. This was followed by gear restriction (30.0%). Results of Chi-square analysis revealed that there were significant associations between level of household livelihood diversification and fishermen's agreement with gear restriction ($\chi^2 = 15.545$, df = 5), and closed season ($\chi^2 = 11.214$, df = 4). The study concluded that coastal fisheries is in a poor state and that it could be improved through the introduction of gear restriction and closed season policies. The study recommended that youths in the coastal areas should venture into fishing, and that government and non-governmental agencies should organize sensitization programmes on fisheries conservation policies across the coastal areas in Ogun State.

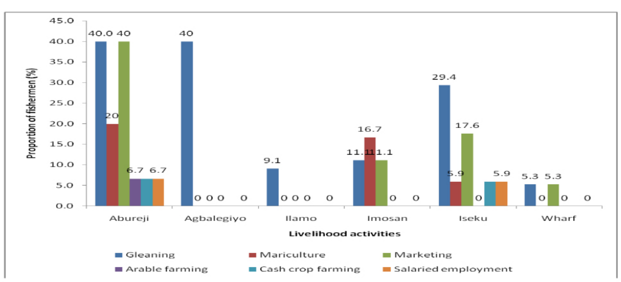

Figure 1: Livelihood activities of fishing households by fishing villages

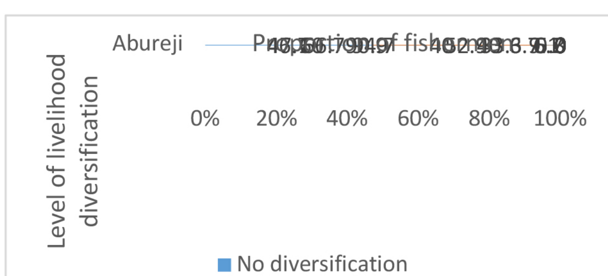

Figure 2: Levels of fishing household livelihood diversification by communities
Coastal fisheries conservation

DETERMINANTS OF THE PROFITABILITY OF CATFISH PRODUCTION AMONG FARMERS IN OYO STATE, NIGERIA

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This study examined the profitability of catfish production in Oyo State, Nigeria. A total of 120 african catfish (Clarias gariepinus) producers were randomly sampled and data were collected through an interview guide (questionnaire). Descriptive and inferential statistics. (Frequencies, Percentages, means, and Standard deviation, Budgetary analysis, and multiple regression analytical techniques) were employed for data analysis. Findings showed that majority of the catfish farmers were male (99.2%), and are into full time catfish farming (82.5%), this group have less than 20years experience in catfish farming with mean fish farming experience of 12.1±5.9 years. More than half (57.5%) had tertiary education while 41.7% had either primary or secondary education. The total cost of catfish production was estimated to be ₦2,451,881.0 per production cycle, and the total revenue generated was ₦2,752,883.3 per production cycle. The net farm income was ₦301,002.4 per production cycle. High cost of feeds ($\bar{x}$ = 3.32±0.75), high cost of pond construction ($\bar{x}$ = 3.05±1.17), inadequate fund ($\bar{x}$ = 2.92±0.73) and high cost of fish seeds ($\bar{x}$ = 2.29±1.16) were severe constraints to catfish farming. The regression analysis showed that the quantity of catfish harvested (β = 0.636, $p \leq 0.01$), price per kilogram of table size fish (β = 0.246, $p \leq 0.05$) and kind of fish seed stocked (β = 0.204, $p \leq 0.05$) were significant determinants of profitability of catfish production. The study concluded that catfish production was a profitable enterprise, and improving infrastructural facilities can enhance productivity and profitability.

Table 1: Production characteristics of fish farmers (n=120)

Variable	Frequency	Percentage	Mean±SD
Number of ponds			
1-5	50	41.7	
6-10	54	45.0	8±5
>10	16	13.3	
Pond size(m²)			
<1000	34	28.3	
1000-3000	50	41.7	2007.5±1586.5
>3000	36	30.0	
Number of production cycle/year			
1-3			
4-6	115	95.8	2.4±0.9
>6	4	3.3	
	1	0.8	
Length of production cycle (months)			
1-5			
6-10	64	53.3	
>10	50	41.7	5.4±2.1
	6	5.0	
Quantity of fish stocked			
<1000	36	30.0	
1000-3000	78	65.0	1628±818
>3000	6	5.0	
Price per Kg (₦)			
≤1000	114	95.0	
>1000	6	5.0	883.3±197.2
Quantity produced (Kg)			
<1000	14	11.7	
1000-5000	96	80.0	3194±524kg
5001-10000	7	5.8	
>10000	3	2.5	

Source: Field survey (2021)

SPECIAL SESSION
REFLECTIONS ON THE CAREER OUTCOMES OF AQUACULTURE EDUCATION: A NETWORKING EVENT

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Redesigning Aquaculture Training for the African Blue Economy Revolution

African aquaculture has grown from the subsistence level targeted at providing fish to feed households in ponds to commercial ventures in cages, tanks, bioflocs and recirculation systems. While the early generation of African aquaculturist were trained outside the continent on production systems, species and work ethics, overtime, African aquaculture has come of age with a new a crop of young entrepreneurs who are upscaling their micro- and small ventures to the medium and commercial operations. There is the need for a new cohort of commercially oriented managers who understand the African terrain and can adapt technologies from the west and Asia to spur the African blue economy. This next breed should have at their finger tips the core aquaculture competencies: hatchery management, fish nutrition, production systems for the commonly culture species, post-harvest processing, marketing and financing of aquaculture ventures in addition to an in-depth understanding of the socio-cultural dynamics of their operational areas for human management and peaceful co-existence with local authority and communities. A steep knowledge in procurement, logistics and supply chains and sustainability is a core survival competency in the industry. To achieve this there is the need for a dynamic shift from the traditional training of aquaculturist to embrace online modules, industry immersion and problem-based solutions at the industry level to launch African aquaculture into the next phase.

DRIVING INDUSTRY TRANSFORMATION IN GHANA

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In 2023, the Blue Food Partnership (BFP) Ghana Initiative launched, aimed at boosting sustainable aquaculture in Ghana. It is led by the World Economic Forum's Friends of Ocean Action, with global technical support from FUTUREFISH and the Chamber of Aquaculture Ghana as the local secretariat. The initiative developed a collaborative multi-stakeholder partnership platform to identify priority issues and solutions, co-create the BFP Ghana Action Plan and form Task Forces to deliver solutions against that plan, emphasizing private sector leadership in sustainability and growing Ghana's aquaculture sector.

With the sector in Ghana setting out on an ambitious future to transform the country into a regional Blue Foods hub, the topic of standards linked to critical issues in the industry has become increasingly relevant. The Chamber of Aquaculture Ghana and the Aquaculture Stewardship Council (ASC) have started to explore the development of a local Code of Good Practice (CoGP) that would introduce a set of sustainability requirements for the industry to work towards. These requirements will be informed by the science and consensus building through multi-stakeholder dialogues by the ASC in the development of its Farm Standard, creating a voluntary CoGP that the sector can use to demonstrate responsible environmental and social performance against. With a growing middle class and increasing concerns from consumers around food safety issues related to water quality and fish health, demonstration of compliance against the CoGP can create differentiation in the market place and harness the value of responsibly produced aquaculture products in Ghana.

In this session, Jacob Adzikah, CEO of the Chamber of Aquaculture Ghana, and Roy van Daatselaar, ASC's Head of Improver Programme, will explore how Ghana's vision and ambition to transform it's industry can be channeled by the development of a Ghana led and owned Code of Good Practice, how the private sector can take ownership and course of action by developing and shaping a domestic market that recognizes sustainability and ultimately drives sector transformation.

APPLICATION OF EPIC MARKERS TO CROSS-AMPLIFY TILAPIINE SPECIES IN EAST AFRICA

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Fisheries and aquaculture are vital for regional food security and economic development. Tilapiine species, especially those from the *Oreochromis* genus, play a central role in fisheries and aquaculture due to their adaptability to diverse aquatic ecosystem. This study responds to the growing need for molecular tools to monitor genetic diversity in tilapiines, as climate change and aquaculture intensification increasingly threaten both wild and farmed populations by exacerbating disease outbreaks and accelerating genetic diversity loss. By developing Exon-Primed Intron Crossing (EPIC) markers that cross-amplify species, we provide a resource to support biodiversity assessment and conservation efforts in East Africa. Using EPIC markers targeting immune genes, this study examined genetic diversity, population structure, and differentiation of tilapiine species and populations in East African water bodies and aquaculture farms. Fifty (50) EPIC markers were designed, and 45 successfully amplified target regions across diverse species: *Oreochromis niloticus*, *O. esculentus, O. leucostictus, O. variabilis,* and *O. jipe*.

Genetic diversity varied among the wild *O. niloticus* populations, with higher heterozygosity observed in Lake Turkana (He = 0.467) and lower in Lake Jipe (He = 0.312). Similarly, Lake Victoria showed higher diversity (He = 0.362) and Lake George (He = 0.349), compared in Lake Albert (He = 0.329). Populations from Lake Hashenge (He = 0.147) showed reduced diversity relative to those from Lake Chamo (He = 0.237) and Lake Tana (He = 0.151). Among the farmed populations, diversity was higher in Kyanamira population (He = 0.393) and reduced in Kajjansi (He = 0.372). Populations from Lake Albert and Lake Kyoga exhibited higher gene flow (FST = 0.017) in comparison to Lake Tana and Lake Hashenge (FST= 0.579). Similarly, between farmed popuations, high gene flow was observed between Kyanamira and Kajjansi (FST = 0.033). AMOVA results indicated 53% of the total genetic variation was found among populations, while 40% occurred within populations, highlighting a moderate diversity within populations. STRUCTURE analysis identified 12 major genetic clusters (K = 12) among populations. Uganda populations (Albert, George, Kajjansi, Kyanamira, Kyoga and Victoria) formed a distinct cluster, while those from Lake Chamo, Hashenge and Tana formed a distinct cluster. Multivariate analyses based on Principal Coordinate Analysis (PCoA) and Neighbour-Joining revealed distinct clusters by species and geographical location. *O. niloticus* Tana populations show distinct cluster and distance compared to Uganda populations that are clustered together Kyoga, Victoria, Kyanamira, George, Kajjansi and Albert. *O. esculentus* from Kanyaboli and Bisina show a lower genetic distance (FST = 0.120).

The observed genetic diversity, gene flow, and population differentiation confirm the applicability of EPIC markers as molecular tools for monitoring biodiversity and guiding the conservation of tilapiine species under increasing anthropogenic and environmental pressures.

EVALUATING LOCALLY ALTERNATIVE INGREDIENTS FOR SUSTAINABLE FISH FEEDS IN ZAMBIA: NUTRITIONAL AND DIGESTIBILITY ASSESSMENT

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The expanding aquaculture sector in sub-Saharan Africa, driven by increasing food security and economic development goals, has led to a growing demand for feed ingredients. However, reliance on imported and often expensive conventional feed components presents significant challenges due to high costs, environmental concerns, and supply chain instability. Therefore, there is an urgent need to identify alternative, locally available feed ingredients and develop sustainable, economically viable aquafeeds using alternative local resources.

Within the framework of the *Development and Scaling of Sustainable Feeds for Resilient Aquatic Food Systems in Sub-Saharan Africa (FASA)* project, a key objective is to generate new knowledge on the nutritional value and digestibility of locally sourced feed ingredients to support the formulation of novel, locally produced aquafeeds. The aim is to develop cost-effective and environmentally sustainable diets that reduce dependency on imported ingredients while supporting the resilience of local aquaculture systems.

The study involves the systematic evaluation of selected local ingredients through proximate composition analysis, quantification of anti-nutritional factors, and in vivo digestibility trials using GIFT strain (*Oreochromis niloticus*). Apparent digestibility coefficients (ADCs) for dry matter, crude protein, crude lipid, crude fibre, gross energy, and selected micronutrients were determined using standard faecal collection and indigestible nutrient marker techniques.

Results from the laboratory analysis and digestibility assessments of feed ingredients sourced in Zambia provide information on the nutrient availability and digestibility profiles, highlighting both the potential and limitations of specific ingredients for inclusion in tilapia diets. These findings provide foundational data critical for the development of balanced, nutritionally adequate, and economically feasible feed formulations.

Overall, the study demonstrated the viability of selected local ingredients in formulating feasible aquafeed therefore contributes to a growing evidence base supporting the sustainable intensification of aquaculture activities in sub-Saharan Africa through the strategic use of locally available resources.

FLESH QUALITY AND PRODUCTION ECONOMICS OF AFRICAN CATFISH (*Clarias gariepinus*) FED A COMBINATION OF COMMERCIAL DIET AND BLACK SOLDIER FLY LARVAE (BSFL)

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The African catfish (*Clarias gariepinus*) is a widely consumed freshwater fish in Nigeria, prized for its taste and texture. It requires a diet with balanced nutrients, including vitamins, minerals, and amino acids. However, high feed costs—over 50% of production expenses—pose challenges for farmers. Black soldier fly (BSF) larvae offer an eco-friendly, cost-effective protein source, cultivated using organic waste. Fish flesh quality depends on biochemical composition, sensory evaluation, and processing factors like water-holding capacity and cooking loss. This study examines BSF larvae's potential to enhance aquaculture and improve fish flesh quality.

The experiment at the FAO/U.I. BSFL culturing unit and the University of Ibadan's (Nigeria) aquaculture farm involved 105 *Clarias gariepinus* juveniles (63.5g average weight) in five treatment groups: (1) 100% commercial diet, (2) 40% BSFL + 60% commercial diet, (3) 80% BSFL + 20% commercial diet, (4) 100% BSFL, and (5) 100% formulated diet. Fish were fed twice daily for 10 weeks. Flesh quality was assessed using sensory evaluation, proximate analysis, gutting yield, water-holding capacity, and cooking loss. Economic analysis examined cost-effectiveness.

Fish fed 40% BSFL achieved the highest gross profit compared to the 100% commercial diet, with Treatment 2 providing the best balance between growth and profitability. BSFL, an eco-friendly alternative to commercial feeds, meets growing consumer demand for sustainable food. Proximate analysis showed variations in moisture, protein, fat, ash, and carbohydrates. Cooking loss remained unaffected, but BSFL-fed fish retained more water, improving tenderness. Combining BSFL with commercial feed enhanced water retention and offered sustainability benefits.

This study confirms that integrating BSFL into fish diets reduces costs while maintaining profitability, offering a sustainable, affordable alternative for aquaculture expansion.

Table 1: Economic Evaluation of BSFL Inclusion on Feed Efficiency and Profitability in African Catfish

Parameters	T1	T2	T3	T4	T5
Final weight	387.50±16.17[e]	305.13±7.62[d]	245.27±9.31[b]	189.07±1.16[a]	278.67±9.70[c]
Price of juveniles (#)	1470.00±0.00	1470.00±0.00	1470.00±0.00	1470.00±0.00	1470.00±0.00
Feed cost	11297.60±0.00	6871.34±0.00	4017.52±0.00	2593.93±0.00	8039.29±0.00
Variable cost	17377.60±0.00[e]	12951.34±0.00[c]	10097.52±0.00[b]	8673.93±0.00[a]	14119.29±0.00[d]
Fixed cost	9200.00±0.00	9200.00±0.00	9200.00±0.00	9200.00±0.00	9200.00±0.00
Total cost	26577.60±0.00[e]	22151.34±0.00[c]	19297.52±0.00[b]	17873.93±0.00[a]	23319.29±0.00[d]
Total revenue	62658.75± 2615.39[d]	59806.13± 1492.99[d]	42063.23± 1596.46[b]	32424.93± 198.77[a]	47791.33±1663.67[c]
Gross profit	36081.15±0.00[e]	37654.79±0.00[c]	22765.71±0.00[b]	14551.00±0.00[a]	24472.04±0.00[d]
Profit Index	232.71±9.65[a]	365.58± 3.72[c]	440.07±14.70[d]	492.64±2.05[e]	249.87±8.34[b]
Breakeven price	9.81±0.41[a]	10.38± 0.26[a]	11.25±0.42[b]	13.51± 0.08[d]	11.96±0.41[c]
Break even yield	8.05±0.00[e]	5.54±0.00[c]	5.51±0.00[b]	5.11±0.00[a]	6.66±0.00[d]

Mean ± SD with same superscripts on same row are not significantly different ($p>0.05$)

Table 2: Consumer Sensory Assessment of African Catfish (*Clarias gariepinus*) Fed Black Soldier Fly Larvae-Based Diets

SENSORY EVALUATION	T1	T2	T3	T4	T5
COLOUR	5.67 ± 2.31	6.33 ± 0.58	5.67 ± 1.53	5.67 ± 3.06	8.33 ± 0.58
AROMA	3.67 ± 1.16	5.00 ± 1.00	5.00 ± 0.00	5.00 ± 2.00	5.00 ± 2.65
FLAVOUR	4.33 ± 2.08	5.00 ± 1.00	5.00 ± 0.00	5.00 ± 2.00	4.33 ± 3.22
TASTE	5.67 ± 0.58	5.33 ± 0.58	5.67 ± 0.58	6.67± 1.16	6.67 ± 0.58
JUICENESS	6.33 ± 1.16	6.00 ± 0.00	6.00 ± 1.00	7.00 ± 1.00	5.00 ± 3.47
OVERALL ACCEPTABILITY	6.00 ± 1.00	5.00 ± 1.00	6.33 ± 1.16	7.33 ± 0.58	6.33 ± 2.08

INTEGRATED AGRICULTURE-AQUACULTURE AS A LEVER FOR ECONOMIC DEVELOPMENT: ANALYZING DRIVERS, PRESSURES, STATE, IMPACT AND RESPONSE (DPSIR)

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INTRODUCTION

Integrated agriculture-aquaculture (IAA), particularly rice-fish farming, presents a viable strategy for enhancing rural economic development and sustainable livelihoods by diversifying income sources, optimizing resource-use (land water, biodiversity), promoting rural enterprise development, and strengthening resilience to socio-economic shocks. Despite its potential economic benefits, wide scale adoption across sub-Saharan Africa has remained low due to constraints in access to critical inputs (seeds, feeds), weak market linkages, and fragmented institutional support. This study applies the DPSIR (Drivers, Pressures, State, Impact, Response) framework, and analyzes the interconnected social-economic-environmental-people dynamics that shape IAA adoption and provide a structured lens to understand the process for scaling integrated systems as a lever for inclusive rural economic transformation.

METHODOLOGY: The combined sustainable livelihoods and DPSIR approach

The methodological process for this study began with the identification of the rice-fish system as the focal integrated agriculture-aquaculture model. Sustainable livelihood indicators, and ecosystem services indicators were then defined to guide the assessment. Field surveys were conducted using qualitative questionnaires, and analyzed to capture key livelihood and environmental variables, followed by descriptive data analysis to interpret patterns and relationships. These insights informed the development of an adapted DPSIR (Drivers, Pressures, State, Impact, Response) framework tailored to the rice-fish system for evaluating its contribution to economic development and sustainable livelihoods. Thereafter, the DPSIR framework was applied to identify priority areas for targeted policy interventions that can support broader adoption and impact.

RESULTS AND DISCUSSION

At the foundation of this system are the drivers, which reflect the underlying motivations that prompt governments, communities, and individual farmers to adopt integrated agriculture-aquaculture. Key drivers identified include increased demand for enhanced farm productivity (measured by yield, food item diversity, and seasonality), improved food and nutrition security, income generation, poverty alleviation, effective wetland management, and adaptation to climate variability (dry spells, flood, water stress). These drivers produce both environmental and anthropogenic pressures that include modification of existing agricultural fields to allow for farm diversification, altered on-farm hydrological regimes, pest and disease control measures, initial biodiversity stress as a result of the field modification, and intensified use of organic and inorganic inputs (fertilizers, pesticides). These pressures, both environmental and decision-driven, lead to observable state changes, such as improved water conservation efficiency, more sustainable land use, reduced pesticide reliance, enhanced biodiversity, and better soil fertility and flood regulation. These ecological and biophysical changes yield indirect impacts which arise from improved ecosystem services, particularly provisioning (crops, fish, other aquatic foods), regulating services (disease and pest control, flood and climate regulation), and supporting services (nutrient cycling, primary production, biodiversity maintenance). This shift supports sustainable livelihoods by strengthening the base upon which rural households build resilience and pursue development goals (the drivers). Simultaneously, the analysis documented direct impacts such as increased livelihood diversification, higher household income, market access expansion, food and nutrition gains, poverty alleviation, improved dietary diversity, enhanced wellbeing, educational opportunities and increased knowledge dissemination on IAA among smallholder farmers. These gains are facilitated by responses that include farmer-led initiatives, community-driven knowledge sharing, government support, and technical training provided by formal and informal extension advisory services.

CONCLUSION

This study concludes that IAA serves as an effective economic development lever by addressing core drivers of economic development, and responding to underlying environmental, social, and economic sustainability requirements required to sustain enabling conditions for inclusive, scalable and sustainable transformation of local economies. The DPSIR analysis demonstrates that the adoption of rice-fish systems as an IAA, when strategically implemented, can drive transformative changes in rural economies.

EVALUATION OF GROWTH PERFORMANCE AND FEED UTILIZATION OF FARMED AND WILD STRAINS OF NILE TILAPIA (*Oreochromis niloticus* L.1758) REARED IN HAPA UNDER CONCRETE POND

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Nile tilapia is the most suitable fish for aquaculture. However, quality Nile tilapia seed for aquaculture practice is still the main challenge in Ethiopia. This study was to evaluate the growth performance and feed utilization of Farmed and wild strains. Wild brood stocks were collected from natural lakes and the Farmed strain was obtained from Center for Aquaculture Research and Education Site.75 mixed-sex fingerlings from each strain were stocked in triplicates using a CRD at a density of 5.7fish m^{-3}in hapa. The initial weight of tested strains at stocking were 8.1±0.15g (Farmed), 8.2±0.14g (Chamo), 8±0.11g (Koka) and 7.8±0.07g (Ziway) and reared for 90 days. The fish were fed three times a day diet having 30% crude protein at 5% feeding rate. Fish samples were taken bi-monthly for weight measurement. Proximate composition was analyzed following standard methods of AOAC. The Farmed strain had higher final body weight, weight gain, daily growth rate, specific growth rate, feed conversion efficiency, protein efficiency ratio and better feed conversion ratio than Koka and Ziway strains, while Ziway strain had the poorest performance among the four tested strains. This might be due to genetic variation that exploited through selective breeding. The Chamo strain had higher condition factor than Koka strain. The Chamo strain had the highest crude lipid and the lowest crude protein among the tested strains. Chamo male had higher crude protein and crude lipid than Chamo female crude protein and crude lipid. In conclusion, the Farmed and Chamo strains had the best growth performance and feed utilization efficiency which might be sources of quality Nile tilapia seed.

SYNERGISTIC EFFECTS OF PROBIOTICS AND FISH-OIL ON THE GROWTH PERFORMANCE, IMMUNE RESPONSE, AND GUT HEALTH OF AFRICAN MUD CATFISH (*Clarias gariepinus*)

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A major challenge in aquaculture is the high cost of quality dietary protein sources. This study evaluated the synergistic effects of probiotics and fish oil supplementation on the growth performance, immune response, and gut health of African mud catfish (*Clarias gariepinus*). Five iso-nitrogenous (40%) and iso-lipidic diets were formulated by replacing fishmeal (FM) with defatted *Hermetia illucens* larvae meal (BSFL) at 0% (control), 25%, 50%, 75%, and 100% inclusion levels, respectively, fortified with 2% probiotics and 5% fish oil . Each diet was fed to triplicate groups of 10 fish (9.12±0.50 g) at 4% body weight daily for 12 weeks. Growth performance, feed conversion ratio (FCR), specific growth rate (SGR), and haematological parameters were assessed. Antioxidant enzyme activity (catalase, superoxide dismutase, glutathione peroxidase), serum biochemistry, and digestive enzyme activities (amylase, lipase, proteinase) were analyzed. Histological examination of the liver was conducted to assess metabolic stress.

Results showed that fish fed the 75% replacement diet had the highest final body weight (38.63±0.47 g), weight gain (29.97±0.34 g), and SGR (1.78±0.00 %), with a significantly improved FCR (1.85±0.02) compared to the control (2.08±0.24). Packed cell volume (28–35%), haemoglobin concentration (9.5–12.2 g/dL), and red blood cell count (1.44–2.23 $\times 10^{12}$/L) increased significantly ($p<0.05$) in diets with higher BSFL inclusion. Fish fed 100% BSFL exhibited the highest catalase (0.7±0.05 U/L) and superoxide dismutase (4.96±0.12 U/L) activities, suggesting enhanced oxidative stress management. Serum total protein (42.9±1.38–47.4±2.98 g/dL) and albumin (24.9±1.2–27.9±1.30 g/dL) were significantly higher ($p<0.05$) in fish fed BSFL-based diets. The lowest aspartate aminotransferase (81.5±6.20 U/L) was recorded in the 75% replacement group, indicating reduced hepatic stress.

Histological analysis revealed moderate hepatocyte vacuolation and necrosis in groups with high BSFL inclusion, suggesting potential metabolic stress at higher replacement levels. Digestive enzyme activities were significantly ($p<0.05$) higher in fish fed BSFL-based diets, with the highest amylase (0.692±0.082 U/L) and proteinase (0.49±0.63 U/L) activities recorded in the 100% replacement group. This study concludes that replacing FM with BSFL fortified with probiotics and fish oil up to 75% enhances growth, immune response, and gut health in *C. gariepinus* without compromising physiological integrity.

UNDERSTANDING THE INTERPLAY BETWEEN AQUACULTURE, FISHERIES, AND TRADE: IMPLICATIONS ON FOOD AND NUTRITIONAL SECURITY

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The excessive use of aquatic habitats in African nations has severely affected fish populations, reducing wild-capture fisheries for food and nutritional security. This situation has led to a greater dependence on imports and aquaculture. However, this dependency often overlooks the need to sustain wild fisheries, particularly in regions where fish is not just food to satisfy hunger but a vital source of nutrients for many, especially in Africa, where it forms a key part of the diet.

This study explores and compares the interplay between aquaculture, fisheries, and trade and how they impact food and nutritional security across 18 African countries. Our goal is to promote a balanced approach that strengthens sustainable aquaculture, supports the conservation of wild stocks, and manages trade in ways that prioritize local food and nutritional needs.

MORPHOMETRIC, MERISTIC AND BACTERIOLGY OF *Oreochromis niloticus* BOUGHT AT OLOMORE FISH MARKET, ABEOKUTA, OGUN STATE, NIGERIA

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Eighteen specimen of *Oreochromis niloticus* was procured at Olomore fish market Abeokuta, Ogun State, Nigeria. The length weight relationship, morphometric and meristic measurement was studied on the samples and they were also examined for bacteria pathogens from the gut, gill and skin of *Oreochromis niloticus* by asepitically removing and weighing 1 gram each of the skin, flesh and gut for the test. Serial dilution was done to give 10^5 dilution of the original stock culture. The cultural, morphological and biochemical characteristic of the isolates were done. The different bacteria were isolated and tested for their sensitivity to different anti biotics. A total of four (4) bacteria were identified (*Salmonella sp*., *Escherichia coli*, *Streptococcus faecalis* and *Staphylococcus aureus)*). The one tail T-test conducted for combined and separate sexes of *Oreochromis niloticus* showed that there is no significant difference in the weight of the sexes (87.93) with the range of 1.17 to 168.6. The meristic count showed no significant difference in both sexes as the dorsal spine (1) in both sexes, dorsal ray (6-7) in both sexes, pectoral fin ray (8) in both sexes, pectoral spine (1) in both sexes, pelvic spine (0), in both sexes, pelvic ray (10-11) in both sexes, Anal ray (8-9) in both sexes, anal spine (0) in both sexes. The bacteria count in the gut of the present study recorded the highest in the male (1.53) and female (1.37) *Oreochromis niloticus.*

CHARACTERIZATION OF *Edwarsiella tarda* AND SELECTED BACTERIOPHAGES FOR DEVELOPMENT OF AN ALTERNATIVE ANTIMICROBIAL AGENT FOR USE ON FISH FARMS IN UGANDA

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The requirement for minimized use of antibiotics and the ban on antibiotic-supplemented feeds calls for alternative disease control approaches, like the use of bacteriophages (viruses of bacteria). Currently, there are no locally characterized bacteriophages against *Edwardsiella tarda* as a cheap alternative for the management of "Edwardsiellosis" on fish farms in Uganda. This study characterised *in vitro*-lytic activity and genotypic properties of selected bacteriophages against *E. tarda*.

Edwardsiella tarda-specific phages from the gut contents of market fresh tilapia fish were isolated and purified by the double agar overlay plaque technique. Spot assay was used to determine *in vitro*-lytic activity, pH and temperature stability; as well as one-step growth curve and antibiofilm activity. Oxford Nanopore Technology and Illumina technology were used to sequence the genomes of the host bacteria and one phage strain, respectively. A *de novo* genome assembly was done using various bioinformatic tools. Presence of resistance and virulence genes was determined using bact_hybv4 and online public bioinformatics websites. Phylogenetic tree for both phage and host genomes were constructed using Mega11 and edited using FigTreeV1.4.4 software.

Results:
Three lytic phages against *E. tarda*, viz USF_EDP_P1, USF_EDP_P2, and USF_EDP_W10 were identified. Plaque sizes ranged from 1-2mm; efficiency of plating (EOP) of 1, Multiplicity of Infection 0.4 - 0.8. Only one phage USF_EDP_W10 demonstrated high host range with a burst size of 400 PFU/infected bacterial cell and, burst time of 10 minutes (Fig 1A). Highest phage stability was recorded between -20°C and 30°C and pH of 7-7.5 (Fig 1B and C). The phage exhibited antibiofilm activity. Predicted genes of phage genome included holin, endolysin, and spanin but not AMR and virulence genes. Phylogenetic tree structure clustered the phage USF_EDP_W10 together with the genus *Moonvirus*.

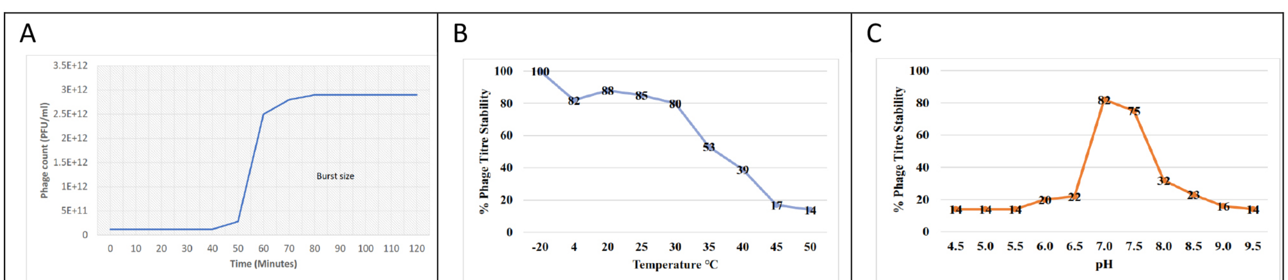

Fig1. One growth curve (A), Temperature (B) and pH (C) phage stability after 60 min exposure

Genotypic characterization and *in vitro* lytic activity of USF_EDP_W10 revealed it as a virulent phage and its potential application for edwardsiellosis management in aquaculture.

TOWARDS FIT FOR PURPOSE FISHERIES AND AQUACULTURE EDUCATION BY AU-IBAR CENTRES OF EXCELLENCE

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As strategic hubs for knowledge generation and skill development, the AU fisheries and aquaculture CoEs play a critical role in addressing the continent's food security, environmental sustainability, and economic objectives. Education prepares individuals for life and work by developing their minds and perspectives, while training prepares individuals for specific tasks or roles through skill acquisition. In practice, both are essential, especially in fields like aquaculture and fisheries where professionals need both deep understanding (*education*) and hands-on competencies (*training*).

Centres of Excellence require highly skilled human resources to cultivate adaptability and lifelong learning through education and, job readiness and task performance through training. For the CoEs to be fully fit for purpose to deliver the required human capacity for Africa to transform its fish production output to sustainably meet its food security requirements and develop its 'blue economy', their courses and capacities must be enabled by (i) visionary education leadership that can focus on the recontextualization and reproduction of scientific knowledge to drive the AU aquaculture and fisheries development mandate; (ii) financial resources for on-going professional development of the researchers' curriculum design and teaching competencies for education as well as for training.

This presentation applies Basil Bernstein's concepts of knowledge production, recontextualisation, and reproduction to the analysis of curriculum development processes within emerging Centres of Excellence (CoEs) at African universities, focused on building sustainable human resource capacities in aquaculture and fisheries. Bernstein's *Pedagogic Device* offers a valuable framework for examining how disciplinary knowledge is produced by experts, recontextualised by policy actors and institutional stakeholders, and ultimately transmitted through pedagogic practices to students at the university and adult learners in non-university learning contexts. This presentation explores why and how it is necessary to explicitly structure the knowledge transfer process so that it is appropriate to the needs of AU and member state policies and institutions.

THE DEVELOPMENT OF AQUACULTURE IN UGANDA

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Aquaculture development in Uganda began in 1941, with fish farming officially proposed by colonial authorities. The Kajjansi Fish Experimental Station was established in 1947 to explore the farming of tilapia species. Aquaculture further progressed under the rural development initiative, and by late 1968, most ponds were primarily producing fish for subsistence. However, subsistence farming largely depended on seed supply from farmers or government stations, utilizing family labor, which hindered the expansion of the aquaculture sub-sector.

With strategic interventions from the government and support from development partners such as the FAO and ADB, aquaculture began to thrive, reaching an annual production of 15,000 tons by 2005. Located at the equator, Uganda has high potential for fish farming due to its conducive climate, including ideal temperatures for tilapia and catfish, two distinct rainy seasons, abundant natural water sources such as lakes, rivers, and swamps, flat and gently sloping land, plentiful feed ingredient crops, and access to local, regional, and international markets. Additionally, a favorable investment environment has been created by the government.

The primary objective of these interventions was to commercialize fish farming to generate income, improve nutrition, and create employment opportunities. The fish species cultivated include Nile tilapia, African catfish, and common carp (Cyprinus carpio), particularly in the cooler regions of the country. The most prevalent production systems are extensive and semi-intensive pond-based aquaculture systems. Emerging systems include cage culture and tank farming. Currently, pond culture is the dominant system, while cage culture is mainly practiced on Lake Victoria, alongside the use of concrete tanks. Uganda's estimated annual fish production is 130,000 metric tons (FAO, 2024). Presently, the Uganda Bureau of Statistics (UBOS) is conducting a nationwide census of aquaculture to update statistics for planning and decision-making. Fish markets are primarily local and regional (especially in Kenya, the DRC, South Sudan, and Rwanda), with some producers also exporting to international markets.

Regulations, laws, policies, and guidelines are established to guide the establishment and management of aquaculture. Key regulatory frameworks include the Fisheries and Aquaculture Act (2023), Aquaculture Rules (2022), and the Fisheries and Aquaculture Policy (2018).

Aquaculture development in Uganda is planned with a focus on several areas in the value chain: research and development; quality fish seed production, particularly by the Kajjansi Aquaculture Research and Development Centre (KARDC) for genetic improvement and seed multiplication by private hatchery operators; promotion and empowerment of groups and associations; establishment of community aquaculture production centers; local fish feed manufacture (noting that most feed is imported); provision of quality inputs to model fish farms; capacity building through training, demonstrations, exhibitions, and tours; marketing promotions; and funding through agricultural banks.

Challenges within the aquaculture sub-sector include inadequate knowledge and skills, poor-quality and expensive inputs (especially feed, seed, equipment, and materials), lack of capital, land and water use issues, and inadequate market and marketing infrastructure. Interventions to support aquaculture development include input support from the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) and Operation Wealth Creation (OWC) for farmers; projects such as the Climate Smart Agriculture Transformation Project; additional support from development partners such as GIZ; training of technical officers and farmers; and promotion of farmer cooperatives and associations.

ENVIRONMENTAL ASSESSMENT OF LOCAL ECOHUB FARMS TO DEVELOP VALUE CHAINS OF TILAPIA, SPIRULINA AND INSECT

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The INNOECOFOOD project is developing innovative strategies for sustainable food production in Africa, creating local farms (ECOHUBs) focused on fish, microalgae, and insect value chains, including certified marketable food and feed products, as well as ingredients to other products based on the "farm to fork" approach. The environmental impacts of such a holistic approach, integrating the production of different supply chains in the form of an ECOHUB, will be assessed with Life Cycle Assessment (LCA) methodology. The goal is to assess the environmental footprint of 1 kg of tilapia produced in the ECOHUB. The system will include fish production and processing, together with fish by-products further uses, as well as spirulina and insect-based products/ingredients of relevance to local communities and industries.

All fed aquaculture systems share environmental burdens from feed, but their resource use, emissions, and ecosystem pressures vary. Recirculating Aquaculture Systems (RAS) consist of fish tanks with filters and water treatment for aeration and disinfection. RAS recirculates treated water, converting ammonia into nitrate, which can be denitrified or gathered together with sludge. RAS offer solutions to overcome the main environmental issues by preventing the spread of nutrients, antimicrobials, and invasive species. Furthermore, closed farming systems offer more controlled rearing conditions that may contribute to a lower occurrence of diseases and a more efficient Feed Conversion Ratio (FCR) than traditional open net-pen systems. The improved FCR is achieved through healthier fish and better control of feeding. However, RASs require more technical input and energy to facilitate water aeration and purification in order to create suitable conditions for the fish to live and grow than in open farming systems.

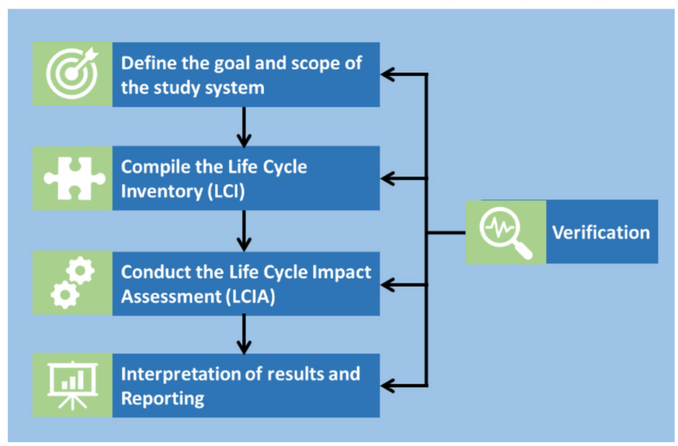

Figure 1. The LCA phases to assess environmental impacts of a product throughout its entire lifecycle.

Tilapia is a highly productive freshwater fish species, that requires low protein inputs and warm water (around 30°C), potentially lowering the environmental footprint. While previous LCA studies highlighted high GHG emissions in RAS due to energy needs, RAS for tilapia and catfish showed lower energy use in Europe, with no oxygenation needed. The multitrophic approach of the ECOHUB, including the whole supply chain with a combination of different species, is a RAS system that goes beyond the aquatic farming system and may improve efficiency in resources use in the agro-food system. Therefore, since LCA is crucial for assessing the environmental impact of tilapia production, the aim of this work is to provide a comprehensive analysis of the entire chain (from raw materials to waste management) in order to help optimize processes and reduce environmental burdens, promoting sustainable aquaculture practices.

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INVESTIGATION OF THE ATTITUDES OF PEOPLE LIVING IN ERZURUM PROVINCE (TURKIYE) TOWARDS FISH CONSUMPTION

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In recent years, the demand for fish/seafood has increased as a result of healthy and balanced nutrition issues gaining importance in developed countries. Fish/seafood, which is more abundant and easier to obtain than other protein sources, have become preferred. The desire to consume food resources from aquatic ecosystems, which has an increasing trend in Türkiye as well as in the world, stands as an undeniable fact. Within the scope of this study, the attitudes of people living in Erzurum province (Turkiye) towards fish consumption were examined. According to the results of the survey in which a total of 344 people participated, it was determined that the proportion of fish consumers was 71.2%. The consumption rate increased with the level of education, reaching the highest value (77.8%) in those had graduate education. The highest consumption frequency was once a month (49.4%), followed by once a week (27.3%). The lowest consumption frequency was every 6 months with 4.5% (Fig. 1). According to fish consumption frequency data, assuming each consumption/portion is 250 g, annual per capita consumption could be calculated as 5.3 kg.

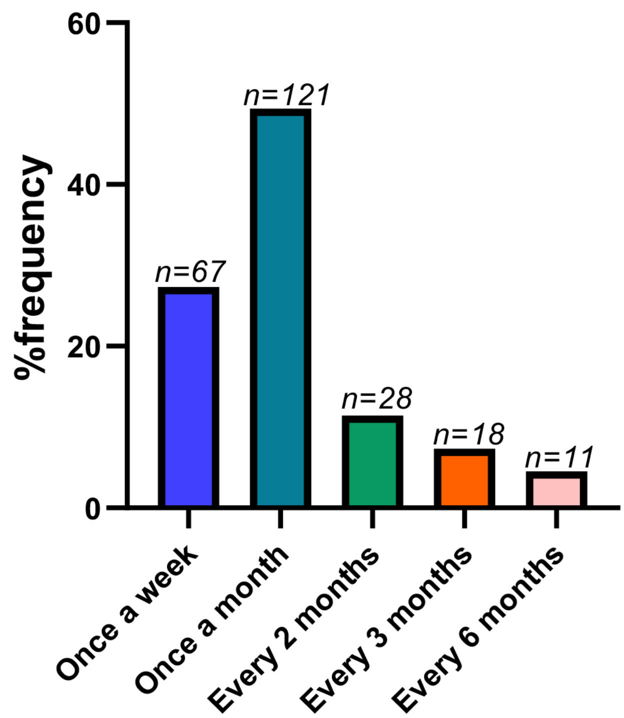

Fig. 1. Consumption frequency (%) of fish consumers

THE PERFORMANCE AND IMPACTS OF THE AFRM TOWARDS PROMOTING COHERENCE FOR THE SUSTAINABLE DEVELOPMENT OF AQUCULTURE IN AFRICA

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The African Fisheries Reform Mechanism (AFRM), is the guidelines for fisheries policy and governance reform that strategically and comprehensively transforms African Fisheries – sustainable management; rational utilization and visionary development. It is an integral part of the Policy Framework and Reform Strategy for Fisheries and Aquaculture.

This responds directly to a call from the first Conference of African Ministers for Fisheries and Aquaculture (CAMFA 2010) for strategic partnerships and the dissemination of best practice in fisheries at the regional level as a means towards raising the need for wide ranging African fisheries policy and governance reforms.

The African Fisheries Reform Mechanism (AFRM) was developed in 2014, in consultation with partners (World bank, FAO, the NPCA-NEPAD, University of Greenwich, RECS, RFBs etc), to create a new, coherent, AU-based regional partnership platform - with the objective of facilitating the development, adoption and implementation of reforms in fishery governance and management that would contribute towards transforming Africa's fisheries from overexploitation and overcapitalization towards environmental, economic and social sustainability.

The AFRM serves mainly as a platform for broad-based consultation to facilitate the Coordination and coherence in fisheries and aquaculture policies, management measures; relevant especially for shared or transboundary fisheries and aquaculture resources; Information sharing; Knowledge generation for evident-based decision making; Advocacy; informed and participatory Policy development; Monitoring progress of implementations of AU Policy Organs' decisions; and Resources mobilization for sustainable fisheries and aquaculture development in Africa.

This presentation will illustrate how AFRM has been used to mobilise resource and stakeholders to promote the sustainable development of aquaculture coherently across the continent.

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DEVELOPMENT STATUS AND TRENDS OF GLOBAL RICE-FISH FARMING SYSTEMS

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Rice fish farming (RF) has been practised for centuries in Asian countries, yet adoption rate remains limited, with many rice producing-nations not integrating aquatic species into their rice fields. This study explores why other countries performs better than others and major limiting factors for implementation and retention of RF. By reviewing RF development status, trends and socio-economic-environment contexts in RF major producing countries including China, Japan, Bangladesh, Thailand, India, Indonesia, Egypt, Nepal, the Philippines, Cambodia, Lao People's Democratic Republic (Lao), Malaysia, Myanmar, Vietnam, and the United States (US). Our study shows that, globally RF production has increased from 88,245.34 tons in 2000 to 423017.58 tons in 2023 accounting for 3.18% of global aquaculture production, occupying 2.24% global paddy field or 0.96% arable land. China is leading in rice-fish production and area followed by Bangladesh and Indonesia. For the last two decades, development trends of RF aquatic food production and area in China, Bangladesh and US has been increasing, however, Thailand, Nepal, Japan, Indonesia, and Egypt have experienced a decrease (Fig.1). Cambodia and Lao primarily practice rice-field fisheries. In Myanmar RF area and production has declined since 2013 due to strict government policy inhibiting transition of the rice-fields to accommodate aquatic species. In contrary, Chinese, Bangladesh, Vietnamese, and Indonesian governments together with non-governmental organizations has been actively promoting RF to enhance ecosystem conservation, income and productivity diversification. Inadequate knowledge and managerial skills, intensification of rice mono-culture, lack of capital and labor, technical and institutional constrains has led to low adoption of RF in various regions globally. Land being a key limiting factor for aquaculture and agricultural expansion, RF therefore is a gateway to specialization, providing nutritious food and economic growth through integration of high-value aquatic species such as red swam craw-fish of China and US, freshwater prawns of Bangladesh, and Tiger shrimp of Vietnam. Integrated RF is therefore an innovative way to sufficiently use resources to increase global agricultural output, alleviate poverty, malnutrition, and hunger at the midst of a changing climate.

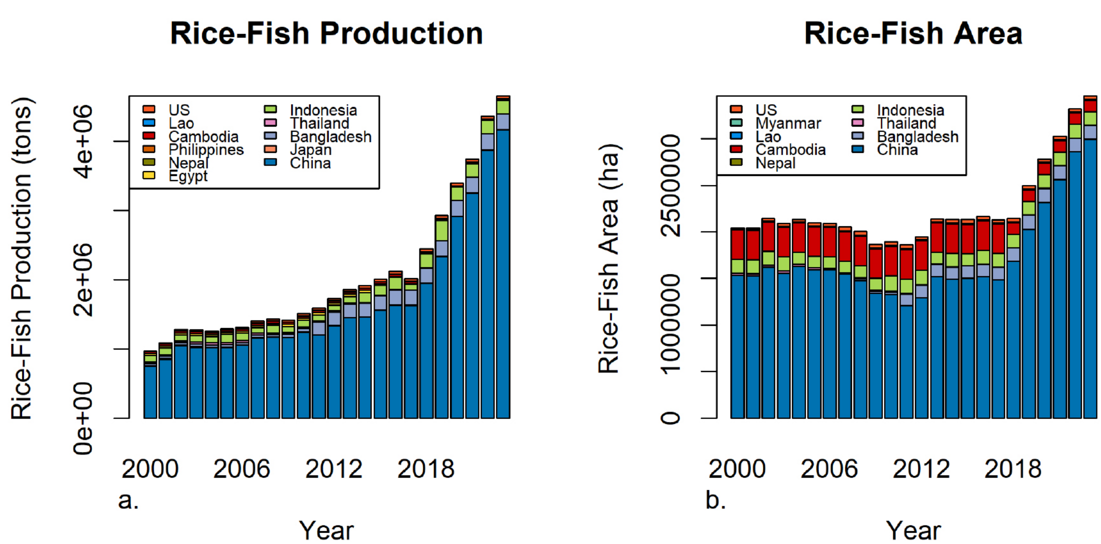

Figure 1: Trends of global rice-fish production (a) and area (b) from 2000 to 2023

GROWTH, FATTY ACID COMPOSITION, AND OXIDATIVE STATUS IN RAINBOW TROUT FED PLANT MEAL/OIL-BASED AND FISHMEAL OIL-BASED DIETS SOLELY OR ALTERNATIVELY

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Growth, fatty acid profile, antioxidant enzymes activities and lipid peroxidation level was investigated in rainbow trout (*Oncorhynchus mykiss*) fed two iso-nitrogenous (48% protein) and iso-lipidic (20% lipid) feeds: FF; fish meal/oil-based, FP; plant meal/oil-based diet with four feeding strategies: 1) only FF, 2) morning FP, afternoon FF (FP/FF), 3) one day FF, the other day FP (FF-FP), and 4) only FP to the apparent satiation for 150 days. The feeding trial was carried out in semi-recirculating water system equipped with 12 tanks (100 L volume), mechanical and bio-filtration, and constant oxygenation, in triplicates.

At the end of the feeding trial, growth performance and feed efficiency were significantly influenced by the dietary treatments ($P<0.05$). The highest growth was observed in the FP/FF group (final weight; 279.7 g), while the lowest growth (final weight; 209.7 g) was observed in the FP group (Fig. 1). Fatty acid composition of the whole-body fish reflected the fatty acid composition of the diets, with significant differences between dietary treatments ($P<0.05$). While the highest total saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), n3, and n3/n6 ratio were detected in the FF group (32.1, 33.3, 22.3 and 1.8, respectively), the lowest values were recorded in the FP group, where the highest polyunsaturated fatty acids (PUFA) were detected (48.7%). Long chain n-3 PUFAs such as eicosapentaenoic acid (EPA, 20:5n-3) and docosahexaenoic acid (DHA, 22:6n-3) decreased with the reception of dietary plant oil. Hepatic lipid peroxidation level (malondialdehyde level; MDA), activities of antioxidant enzymes such as superoxide dismutase (SOD) and catalase (CAT), and total glutathione level were significantly influenced by the dietary treatments ($P<0.05$). The lowest and highest MDA levels were observed in FP (0.48 nmol/mg tissue) and FF (1.21 nmol/mg tissue) groups, respectively.

Our results showed that alternative feeding with FF and FP diets promoted growth in rainbow trout, with the better performance when the interval between 2 diets were shorter. EPA and DHA levels in fish fed only plant oil-based diet decreased dramatically; however, considerable amount of EPA and DHA were secured when 2 diets were used in alternation. Our overall results suggested that using plant meal/oil-based and fishmeal/oil-based diets alternatively could be a good strategy in rainbow trout culture to improve growth and feed efficiency, and oxidative status without dramatic decrease in EPA and DHA.

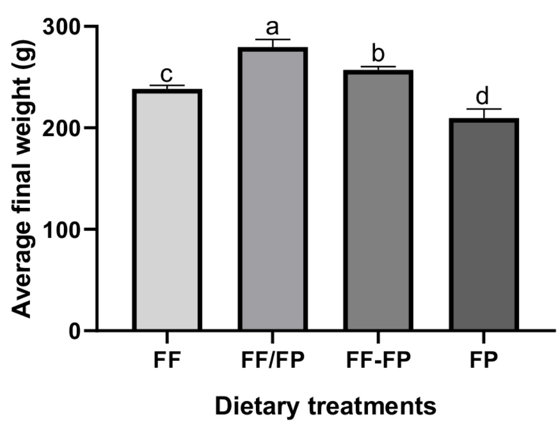

Fig. 1. Mean individual weight in rainbow trout fed fishmeal/oil and plant meal/oil based diets solely or alternatively for days.

CHALLENGES AND OPPORTUNITIES FOR SMALLER HOLDER AQUACULTURE FARMERS' TRANSITION TO AGROECOLOGY IN EAST AFRICA: A CONTEXT OF AQUAPONICS MODELS

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Aquaculture has the potential to make a significant contribution to food security, employment, and income in East Africa. However, attaining sufficiency in food supply to support a growing population without compromising ecosystem functioning remains a top agenda of researchers in East Africa. In this context, efficient and sustainable food production systems such as aquaponics are viewed as an important and environmentally friendly technology for adaptation under resource-limited environments. This review critically examines the status of the different aquaponic systems with varying innovations as part of efficient -water-energy-circular systems for adoption by East Africa farmers. Opportunities for enhancing aquaponic farming are discussed, and based on the current information, suggested strategies, models, and designs are being developed for adoption. Available information shows that, producing food in soilless systems is a promising strategy, as this method utilizes significantly less water than traditional agriculture and takes advantage of the abundant solar energy critical in aquaponics innovation. However, in spite of the fact that aquaponics has the potential to change the phase of conventional agricultural practices, adoption of these technologies by farmers across East Africa is still very low, and is greatly attributed to very limited knowledge of aquaponics relating to suitable systems designs and lack of appropriates inputs hence leading to break-even for profits failure. There is limited expertise to customise the highly sophisticated models and designs used in the developed world. This is coupled with challenges related to changing social customary practices thus undermine diffusion and adoption of aquaponics innovations. Also lack of policy guidelines on aquaponics aspects complicates the situation. Basic modular aquaponic systems that incorporate desirable agroecological aspects that efficiently balances the growth of plants and fish to enhance nutrient utilisation are being proposed. To guide small-scale farmers, three different modular aquaponic systems are being established at Kajjansi Aquaculture Research and Development Centre for optimisation. These include media-based culture (MBC), nutrient film technique (NFT), and deep-water culture (DWC). The developed modular systems will use low-tech installations and making them suitable for use in East African countries.

BREEDING ASPECTS OF MORMYRUS KANNUME IN THE UPPER VICTORIA NILE UGANDA

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The Mormyrus kannume is facing enormous fishing pressure from the fishermen who catch the fish with traps and use it as a bait in Nile perch fishery. As a result, bait fishery targets vulnerable stages of the breeding stages and breeding cycles. There is paucity of information on the current status of the of breeding aspects of the fish. To determine the breeding aspects of M. kannume, a total of 1689 fish samples were collected from upper Victoria Nile between March 2023 and February 2024. Macroscopic and histological analysis of the gonads confirmed that *M. Kannume* spawns throughout the year with a major spawning peak in March coinciding with the onset of rainfall season. The sex ratios did not significantly deviate from the known 1:1. The size at maturity (L_{50}) was recorded in the same size class, at 23.0cm and 21.0cm Total length (FL) for males and females respectively. These results will guide the fisheries sector on regulation of its exploitation and a possibility for developing culture technologies for its increased availability and use for nutrition purpose and as a key source of bait in Nile perch fishery.

ZOOTECHNICAL AND ECONOMIC ASSESSMENT OF TILAVAC S3 VACCINATION IN COMMERCIAL RED TILAPIA *Oreochromis* sp. FARMING: A FIELD STUDY IN THAILAND

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Objective: This study conducted a comprehensive comparative analysis of Red Tilapia (*Oreochromis* sp.) farming operations in a commercial farm in Saraburi Province, Thailand, to evaluate the economic and zootechnical effects of the Tilavac S3 vaccine. The primary goal was to assess the impact of vaccination on key performance indicators and financial outcomes compared to a non-vaccinated control group under real-world field conditions.

Methods: Two batches of Red Tilapia, sourced from the same supplier, were cultured under identical cage-in-river systems. One batch was vaccinated with Tilavac S3, while the other served as a control. Throughout the culture cycles (124 days for the vaccinated group, 126 for the control), data were collected on survival rate, mean body weight, yield, Feed Conversion Ratio (FCR), and total harvested biomass. A detailed financial analysis was also performed, comparing input costs (feed, seed) against the total value of the harvested biomass to determine overall profitability.

Results: The vaccinated batch demonstrated significantly superior performance across all key metrics. The survival rate was substantially higher in the vaccinated group (95%) compared to the control group (81%). This led to a 27.4% greater total weight harvested (3,752.40 kg vs. 2,945.60 kg) and a correspondingly higher yield (37.52 kg/m^3 vs. 29.46 kg/m^3). The vaccinated fish also showed improved feed efficiency, with a lower FCR of 1.55 compared to the control's 1.71. Despite higher total costs due to increased feed consumption for a larger biomass, the vaccinated batch generated a net profit of 45,908.90 THB, over 200% higher than the 15,230.10 THB profit from the control batch.

Conclusion: The findings of this field study unequivocally demonstrate that the use of Tilavac S3 in Red Tilapia aquaculture provides significant economic and operational benefits. The initial investment in vaccination leads to enhanced survival, improved feed efficiency, and greater biomass production. These improvements translate directly into substantially higher profitability and operational stability, presenting a compelling business case for the adoption of this vaccination strategy to enhance the sustainability and financial success of commercial tilapia farming.

EVALUATION OF THE PROBIOTIC ECO MARINE ON WATER QUALITY, PATHOGEN INHIBITION, AND PERFORMANCE OF *Penaeus monodon* IN AQUACULTURE SYSTEMS

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Based on a series of laboratory studies, the commercial product Eco Marine is a bacterial blend primarily composed of three morphologically different strains of *Bacillus* spp. , with a total bacterial count averaging 1.01×10^{14} CFU/g. The product has demonstrated potential for improving aquaculture environments through water quality control and pathogen inhibition.

Eco Marine has shown a significant capacity for nitrogenous waste management. In shrimp rearing water, it effectively reduced ammonium from 0.8 mg/L to 0 mg/L within 8 hours and nitrite from 3.4 mg/L to below 0.5 mg/L in 24 hours at a concentration of 1×10^{8} CFU/mL. Further studies confirmed its ability to suppress ammonia accumulation in both freshwater and seawater, likely through nitrogen assimilation by the bacteria rather than nitrification. While aerobic nitrification was not detected, the product was effective at nitrate and nitrite removal via denitrification under anaerobic conditions, a process that was observed in both freshwater and seawater and enhanced by the addition of an organic carbon source.

The product also exhibits antimicrobial properties. One of the *Bacillus* strains isolated from Eco Marine was shown to inhibit the growth of the pathogenic bacterium *Vibrio harveyi* 1526 in an agar diffusion test. This inhibitory effect was confirmed in a separate colony overlay assay, which produced an average clear zone of 2.97 ± 0.78 mm against *V. harveyi*, suggesting its potential to help control vibriosis in shrimp culture systems.

Furthermore, when used as a feed supplement for the shrimp *Penaeus monodon* at a concentration of 1×10^{6} CFU/g, EcoMarine led to significant improvements in shrimp performance over a two-month trial. Shrimp receiving the supplemented feed had a higher growth rate (1.8 g per 2 weeks) compared to both the control group (1.51 g per 2 weeks) and a group where Eco Marine was added directly to the water (0.99 g per 2 weeks). The feed-supplemented shrimp also showed a higher survival rate than the control group, indicating the product's potential to enhance production.

ASSESSING MARKET POTENTIAL FOR CULTURED *Barbus altianalis* AND *Labeo victorianus* IN UGANDA

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The rising demand for fish in Uganda has heightened the need for sustainable aquaculture options. Among the options is the diversification of farmed fish including high-value indigenous species. Protocols for domestication of *Barbus altianalis,* locally known as Kisinja, and *Labeo victorianus* known as *Ningu* have been developed as part of the strategies to diversify choices for consumers. However, the pattern of demand for these species was paramount in the current study. This study assessed the market potential for *Barbus altianalis* and *Labeo victorianus* by examining fish consumption patterns, species preferences, and willingness to consume and trade these species. A mixed-methods approach was employed. Districts of Buikwe, Busia, Kasese, and Kyotera were purposively selected based on the natural occurrence and trade of the species. A total of 421 respondents were randomly selected from fishing communities. Quantitative data were collected using a semi-structured questionnaire, while qualitative insights were obtained through key informant interviews.

Statistical analyses revealed significant associations between perceptions of the importance of fish across the districts (χ^2 (6) = 23.18, p = 0.007). Kasese district showed the highest preference for Kisinja, attributed to its natural availability and local perception of superior taste. In contrast, Ningu remained less preferred due to limited awareness and low availability, particularly among female respondents and those under 40 years of age. Willingness to consume pond-raised Kisinja (58%) and Ningu (63%) was significantly influenced by income levels (χ^2 (10) = 63.66, $p < 0.001$). While both species are currently traded in small volumes (≤10 kg), over 80% of traders expressed willingness to stock more if the supply increased. Nile perch and tilapia continued to dominate in volume and price per kilogram.

These findings present actionable insights for promoting the culture and commercialization of Kisinja and Ningu, contributing to diversified aquaculture and enhanced food security in Uganda.

"STRENGTHENING INCLUSIVE AND SUSTAINABLE AQUACULTURE THROUGH COOPERATIVE MODELS". THE UGANDA AQUACULTURE COOPERATIVE UNION

Lilian Atukwase

Coordinator Uganda aquaculture Cooperative Union

Uganda's aquaculture sector is undergoing a dynamic transformation driven by increasing demand for fish protein, declining wild capture fisheries, and growing youth interest in agribusiness. However, smallholder fish farmers, who make up the bulk of the sector, continue to face systemic challenges—limited access to quality inputs, fragmented markets, poor extension services, and weak bargaining power. In response to these challenges, the Uganda Aquaculture Cooperative Union (UACU) was established as a national-level cooperative platform to build a vibrant, resilient and sustainable aquaculture industry, enhancing fish production and improving livelihoods for member farmers.The Union is fore seen to create employment of youth, Women,PWD and other adults through resultant activities in the fish value chain such as pond construction,farm attendants,fish distribution,fish processing, transportation and trade in fish value chain products (FAO 2019) Aquaculture employs over one100 Ugandans.

The union is organized in a structured governance and production network premised on 132 POS , 6 regional cooperative unions and an Apex National cooperative union which provides strategic governance and administration. Its core mission is to drive inclusive growth and sustainable practices in aquaculture by providing structured support, market linkage, and collective advocacy for its members. UACU's approach is grounded in cooperative values, leveraging the power of collective action to address systemic barriers while promoting innovation, equity, and environmental stewardship.

The presentation shares the evolution, structure, and impact of UACU, demonstrating how cooperative models can drive resilient and inclusive aquaculture development. UACU has built strategic partnerships with government agencies, research institutions, financial bodies, and private sector actors to deliver coordinated services to its members. These include:MAAIF, Research institutions like Makarere university,NAFIRI in Kajansi, and actors like LVFO,MBCD, training institute like FTI, Entebbe, and donors Eu- Truefish to deliver coordinated services to its members.

UACU has so far registered achievements in access to quality Inputs, Capacity Building and Extension Services, Market Access and Value Addition, Youth and Women Inclusion, Climate Adaptation and Environmental Sustainability.

MARINE SPATIAL PLAN IN RELATION TO AQUACULTURE SUITABILITY

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The Lake Victoria Marine Spatial Plan in relation to Aquaculture Suitability and Carrying Capacity under the Sustainable Activities in Water Areas (SAWA) project is a state of the art and world class decision-making tool-oriented research and management project focused on the Kenyan portion of Lake Victoria. Using applications such as Geostore and AQUA for data processing and the Analytical Hierarchical Process (AHP), the plan delineates the lake into inshore and offshore aquaculture in an innovative web-based tools and products (https://www.sawa.blue/explore). The inshore cage suitable areas optimally range at a depth of about 6 – 10 m alongside constraints like navigation routes, water hyacinth hot spots and breeding areas. The area recommended for inshore aquaculture in the lake is 291 km^2 representing 8% of the lake. The "not suitable" and "less suitable" areas are recommended for accessing the lake for transport, navigation, capture fisheries, tourism, sports and other uses. The recommended inshore aquaculture zones are potential areas for small scale farmers with low capital requirements. The offshore suitable areas that optimally ranges at an optimum depth of about 10 – 50 m for cage culture are alongside constraints like navigation routes, water hyacinth hot spots, and breeding areas. Such installations require firm anchorage to withstand strong currents and could be mainly for capital intensive farms. These sites will be suitable for commercial aquaculture and large-scale farms/firms. It is suggested that the "highly suitable" potential portion of the lake is utilized for cage culture depending on requests from investors after which more room can be sought for "suitable areas" of the lake depending on the existing production carrying capacity. Just like inshore cage farming suitability, the other "not suitable" and "less suitable" areas are recommended for accessing the lake during transport, navigation, capture fisheries, tourism and sports. The carrying capacity of the entire Lake Victoria and with best management practices (BMP) of cage culture is estimated to have a production carrying capacity for riparian counties for cage culture at 275,000 mt p.a.

ADOPTION AND INTENSITY OF INTEGRATED AGRICULTURE AQUACULTURE AMONG SMALLHOLDER FISH FARMERS IN KENYA

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This paper examined the adoption and intensity of using integrated agriculture aquaculture (IAA) among smallholder fish farming households in Kenya. The analysis was based on cross-sectional farm-level data collected from four counties in Kenya: Nyeri, Kakamega, Siaya, and Busia. Results showed that risk plays a central role in farmers' decisions through the direct effect of the sample moments of the profit distribution. Specifically, the first moment (mean profit) had a highly significant positive effect on the adoption and intensity of IAA. Profit variability, as reflected by the second moment, negatively impacted adoption and the intensity of IAA. Other factors that were important in IAA adoption included the proportion of economically active members, full-time land ownership, awareness of IAA, accessibility to irrigation, and flat farm topography, all of which were statistically significant in influencing IAA adoption positively. Other factors which were found to influence the intensity of IAA positively and significantly were: age, education level, number of economically active members, full-time land ownership, awareness of IAA, flat farm topography, and clay soil type. Thus, IAA should be promoted alongside farmers' education, farm size, access to affordable and accessible credit, number of farm enterprises, and IAA awareness as a mechanism for enhancing smallholder IAA adoption and intensity of use.

FISH PROTEIN HYDROLYSATES FROM NILE PERCH RED MEAT INDUSTRIAL BY-PRODUCTS: ENZYMATIC PRODUCTION AND NUTRITIONAL PROFILE

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Background:
Nile perch processing industries in Uganda generate waste and by-products up to 70% of the fish processed, including heads, viscera, skins, bones, and red meat. However, our current technologies and methods for valorizing Nile perch by-products into high-value nutritional products remain limited. Thus, we not only risk polluting the environment due to improper waste disposal but also lose valuable nutrients. The study aimed at optimizing conditions for enzymatic production of fish protein hydrolysates (FPHs) from Nile perch red meat industrial by-products and evaluating their nutritional profile.

Methods:
The defatted sample of Nile perch red meat was hydrolysed using a mixture of Papain and Bromelain (1:1) at concentrations of 0.5%, 1.0%, and 2.0% (w/v) for 30, 60, and 120 minutes. The degree of hydrolysis (DH%) of lyophilized FPHs was evaluated using the o-phthaldialdehyde (OPA) method, the optimum hydrolysis time and enzyme concentration was estimated from the polynomial plot and the proximate composition determined using methods in the Association of Official Analytical Chemists (AOAC). The amino acid profile was analyzed by Fourier Transform Infrared (FTIR) spectroscopy.

Results:
The optimum hydrolysis time and enzyme concentration were 82 minutes and 1.5% (w/v). The fish hydrolysates contained high crude protein and low-fat content (Table 1). The amino acid profile was well-balanced with essential amino acids. Overall, Alanine was the most abundant amino acid at 10.81 ± 0.14 g/100g, Glycine and Glutamic acid at 9.98 ± 0.04 g/100g and 8.41 ± 0.26 g/100g.

Conclusion:
Nile perch red meat is a source of highly nutritious fish protein hydrolysates with strong promise as a valuable dietary supplement suitable for individuals across all age groups

Table 1: Proximate composition of FPHs derived from Nile perch red meat

	Crude protein	Dry matter	Fat	Ash
Mean ± SE	88.39±0.92	13.13±0.14	1.72±0.38	3.46±0.02
N	**3**	**3**	**3**	**3**

SKILLING AFRICA'S AQUACULTURE WORKFORCE

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Africa's aquaculture industry is growing rapidly, offering immense potential for economic development, food security, and youth engagement. However, this expansion is constrained by a significant gap in skilled human resources. The current workforce lacks adequate technical and business training, particularly among women and young people, who are critical to the sector's long-term sustainability.

This presentation explores practical pathways to bridge the skills gap by leveraging inclusive, context-relevant capacity building programs. Drawing on direct experience from regional training initiatives, youth-led mentorship platforms under the World Aquaculture Society (WAS), and academic-industry collaborations, it highlights successful models of workforce development tailored to the African context. Emphasis will be placed on integrating modern aquaculture technologies, soft skills, and entrepreneurship training into formal and informal aquaculture education systems.

The session advocates for long-term investments in mentorship-driven learning, improved training infrastructure, and stronger policy frameworks. By equipping Africa's aquaculture workforce with relevant skills and inclusive support networks, we can catalyze innovation, ensure sustainability, and unlock the full potential of aquaculture as a driver of prosperity across the continent.

ASSESSMENT OF BIOSECURITY COMPLIANCE RATE AND FISH HEALTH MANAGEMENT PRACTICES OF FARMED FISH IN MALAWI: A CASE STUDY OF RUMPHI AND ZOMBA DISTRICTS

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The study evaluated aquaculture biosecurity compliance and adoption rates by investigating 61 fish farms in Rumphi and Zomba districts. Primary data were collected from small-scale pond-based fish farmers through face-to-face interviews using a semi-structured questionnaire. Results revealed poor compliance with biosecurity measures, with an overall average rate of 48.5%. Similarly, the adoption rate of biosecurity measures was unsatisfactory, with an overall average rate of 43%. The study categorized the audited farms based on their compliance levels, with 62.3% falling into the poor compliance category, 36.07% in the intermediate category, and only 1.64% in the good compliance category with aquaculture biosecurity measures. The Mann-Whitney U test revealed significant differences (p=0.026<0.05) in aquaculture biosecurity compliance between the two studied districts, Rumphi and Zomba. Rumphi had an intermediate average compliance rate of 52.42%, while Zomba had a poor average compliance rate of 44.44%. It was noted that many fish farmers in the studied districts react to disease outbreaks instead of taking proactive measures, which may lead to suboptimal disease control. The study highlighted several biosecurity measures posing a significant risk, including unreliable source and movement of fingerlings, sharing of materials such as harvesting nets, lack of quarantine for new fish stocks, improper disposal of dead fish, inappropriate disposal of pond effluent, and the movement of transport vehicles and people on and off the farms. To prevent the spread of diseases and protect fish health, fish farmers in Malawi need to strengthen biosecurity measures through collaboration with government agencies and stakeholders.

ENHANCING SUSTAINABILITY OF AFRICAN CATFISH *Clarias garieinus* SEED SUPPLY IN KENYA THROUGH EFFECTIVE POLICY

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Total annual farmed production of African catfish *Clarias garieinus* in Africa averages 250, 000 tons, with Nigeria, Uganda, Egypt, Ghana, and Kenya being lead producers. Underlying the low farmed production of the species, an important fin fish in aquaculture in the tropics and subtropics, is the poor survival of larval stages. This imperils seed supply needed by farmers to stock their ponds and expand their aquaculture enterprises. One of the causes of poor survival of larvae is the use of poor-quality brood stock of mixed and often uncertain origin. In order to address this, in line with other existing recommendations aimed to boost hatchery raised *C. gariepinus* seeds that also improve conservation of natural populations, a policy on use of nuclei hatcheries that are certified and follow certain guidelines, should be put in place. Here, I will talk about identification of suitable brood stock populations, confinement at select nuclei hatcheries charged with multiplication and distribution of high-quality seed to farmers. Similarly, I will discuss the implications of inertia to fish food production, as well as food and nutrition security in Kenya.

A STITCH IN TIME SAVES NINE: LESSONS FROM BOTSWANA'S NATIONAL AQUATIC ANIMAL HEALTH STRATEGY DEVELOPMENT

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The SADC Aquatic Animal Health Strategy (2016 -2026) was approved and launched by the SADC Ministers of Agriculture and Food Security, and Fisheries and Aquaculture in November 2016. In support of implementing the SADC Protocol on Fisheries, Botswana launched its National Aquaculture Strategy in March 2021 to spearhead the development of aquaculture in Botswana. One of the pillars supporting aquaculture production is biosecurity and aquatic animal health. Through SNRL support, Botswana has developed this draft National Aquatic Animal Health Strategy in alignment with the SADC Regional AAH Strategy and launched it in November 2024. The purpose of the national AAH strategy is to strengthen national capacity in aquatic animal health and biosecurity, and it hopes to achieve this through ten (10) strategic objectives and many activities supporting each objective. The strategy is underpinned by five (5) guiding principles: Science-based research and innovation, Risk analysis, Human capacity and indigenous knowledge, Effective communication and Networking. Against a background of low aquaculture production, poor legal framework and lack of human capacity in AAH, it is projected that aquaculture has the potential to become one of the significant contributors to the GDP of Botswana.

One of the major threats to aquaculture development in Africa is biosecurity, i.e. ensuring proper disease control and management. Millions of wild fish succumbed to epizootic ulcerative syndrome (EUS) in the Chobe-Zambezi system in 2006 and this infection spread throughout southern Africa river systems over the past decade, prompting the development of the SADC Regional Aquatic Animal Health Strategy in 2016. Despite the low uptake of aquaculture as an enterprise, it is encouraging that the Batswana people are now appreciating the need for agricultural diversification to ensure food security and poverty eradication. However, a number of constraints still need to be addressed, the most urgent ones being limited diagnostic capacity, inadequate legislation and lack of human capacity, lack of collaboration, law enforcement limitations and lack of biosecurity/risk analysis training, lack of proper aquaculture/quarantine facilities and aquatic veterinarians, as well as the lack of financial and human resources.

The strategy is benchmarked on the World Organisation for Animal Health's (WOAH) Aquatic Animal Health Strategy (2021-2025), the African Union – Inter-African Bureau for Animal Resources (AU-IBAR) regional capacity and collaboration in animal health and the SADC Regional Aquatic Animal Health Strategy. The purpose of this action is to strengthen national capacity in aquatic animal health and biosecurity in alignment with the regional strategy. It reflects the collective inputs from a wide range of stakeholders through broad-based consultations, as well as desk reviews of existing publications, literature and legal documents. Many of the gaps identified during the consultations informed the structuring of the objectives and activities addressed therein. The strategy also comes with an appended list of fish pathogens and parasites recorded in Botswana, as well as a costed implementation plan. Its immediate implementation gives credence to "a stitch in time saving nine".

THE BRINE SHRIMP *Artemia* IN ANIMAL FEEDS: OPPORTUNITIES IN AFRICA AND ABROAD

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As global demand for sustainable animal protein continues to rise, the search for alternative feed ingredients is becoming increasingly urgent, particularly in regions prioritising food security and economic growth. This presentation will explore the untapped potential of *Artemia* biomass as a valuable component in farmed animal feed, highlighting both emerging opportunities in Africa and broader applications globally. Once limited to hatchery use, *Artemia* is now gaining recognition as a high-quality, multifunctional feed ingredient with applications far beyond its conventional role as live feed in aquaculture hatcheries. High in protein, essential lipids, and bioactive compounds, *Artemia* presents a viable solution for reducing dependence on fish meal, while also enhancing animal health through its natural nutraceutical properties. Its inclusion in feed has shown potential to improve growth performance, immunity, and feed efficiency in aquaculture and other animal production systems. We will explore how Artemia-based feeds can support low-cost, circular feed solutions, particularly in Africa, where feed costs, supply chain challenges, and environmental pressures are key concerns. By utilising local production systems and integrating waste-to-feed models, *Artemia* offers a low ecological footprint and a pathway toward resilient, localised feed value chains. Here, we will highlight case studies, production models, and investment strategies for incorporating *Artemia* into feed strategies across different regions. We will also offer valuable insights for stakeholders across policy, industry, and research, highlighting how *Artemia* can play a pivotal role in advancing sustainable animal feeds, both in Africa and globally.

ASSESSMENT OF MAJOR POINT AND NON-POINT SOURCES OF POLLUTION AND THEIR IMPACT ON AQUATIC ECOLOGY IN WINAM GULF LAKE VICTORIA, WITH IMPLICATIONS ON KEY INDICATOR ORGANISMS

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Water resources plays a key role in the aquaculture, wild fish, domestic use enhances socio-economic development and hence contribute immensely to realization of food and nutritional security. However, since the onset of fish cage culture in the lake, increasing human population created similar increasing demands in agricultural lands, water and with expanding settlements. The changing climatic conditions and fluctuating precipitation, emerging micropollutants and environmental stressors, all contribute to the multiple environmental pressures which threatens the water quality in the lake at large, resulting in degradation of fish and other flora and faunal habitats, increasing vulnerability of endangered species, risks to public health and livelihoods.This pushed for environmental assessment study of the ecological status of the water quality and characterization of pollutants at selected sites from January 2022 to April 2023. In-situ measurement of key water quality parameters was made at eight sampling sites, each having three points using a HANNA HI9829 multi-parameter meter. Ekman grab was used to collect triplicate hauls of the benthic macroinvertebrates samples sieved using 500 micron sorted to species level, nutrients and chlorophyll-a samples was collected and analyzed following standard methods of analysis. Dissolved oxygen, temperature, pH, ORP, Total nitrogen, Total phosphorous ranged from 1.87 – 8.19 mg/L, 23.48 – 29.65 □C, 6.02 – 8.82, -304.40 – 478.3mV, 86.53 – 321.79µg/L, 14.71 – 384.71µg/L respectively. Thus an indication of hypoxic, acidic and toxic environment of pollutants in increased concentrations and lots of dead and decaying material in the water column that cannot be easily cleared or decomposed. Chlorophyll- a as primary productivity and algal biomass indicator tool, recorded a range of 8.96- 294.75µg/L thus an indication of intense eutrophication. TN:TP ratio determines the limiting nutrient in the waterbody, during the study all stations exhibited nitrogen limitation because the ratio of all the sites was below the required standard of > 15. All sites sampled had high tolerance values >5 in benthic macroinvertebrates an indicator of highly polluted ecosystem where an organism resides. This endurance to pollutants for a period of time in a disturbed environment with poor water quality, needs to be regenerated through policy formulation to stem the menace. Waste water planning and management, long term monitoring needs to be sustained to guide on expanding urban development, anthropogenic pressures, impact of climate change and better management of Lake Victoria aquatic ecosystem for harnessing the blue economic growth.

GROWTH PERFORMANCE, HAEMATOLOGY OF TILAPIA *Oreochromis niloticus* FED PHOSPHORUS SUPPLEMENTED DIETS AND PHYSIOLOGICAL RESPONSE OF LETTUCE *Lactuca sativa* IN AQUAPONIC SYSTEM

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Aquaponic is the synergy of aquaculture and hydroponic systems. Nutrient imbalance remains a challenge in aquaponics. Phosphorus is vital for growth in aquaponic. This study assessed the effect of different Phosphorus levels on growth performance, nutritional content and hematological response of *Oreochromis niloticus* and *Lactuca sativa* in aquaponic.

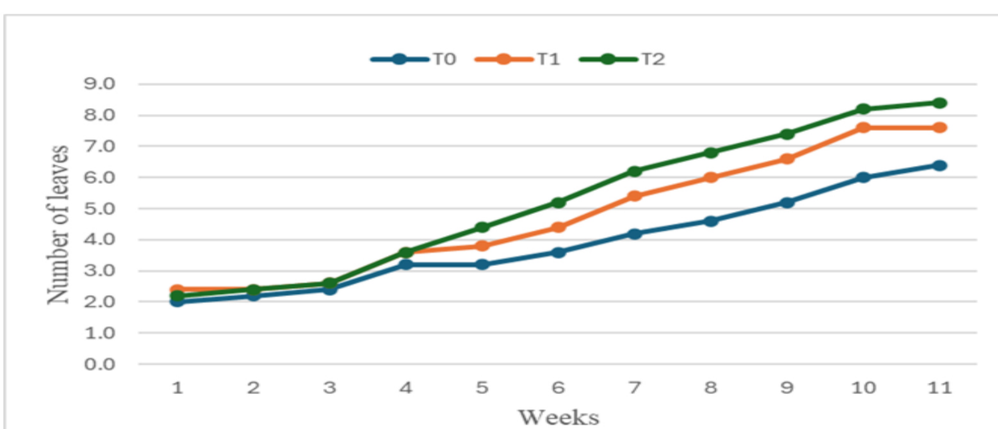
The same commercial diet but with different Phosphorus levels: Diet 1 (T1=5.0), Diet 2 (T2=7.5) and the commercial diet (T0) served as a control. The experiment was conducted in triplicate for 10 weeks.

The increase in phosphorus level in diet was positively correlated with length and weight gain. T2 recorded the highest length (177.77±5.74mm) and weight gain (54.23±3.22g) for *O. niloticus* followed by T1 (Table 1). Also, the highest number of leaves and total lettuce biomass was observed in T2 (figure I). T2 also promotes the welfare of *O. niloticus*. T2 seems to be the best treatment for aquaponic *O. niloticus* juvenile and lettuce.

Table 1: Growth performance of *O. niloticus* in aquaponic systems

Parameters	T0	T1	T2
Initial length /mm	80.78±4.51	80.81±6.12	79.26±10.33
Final length /mm	118.98±4.36	135.84±5.49	177.77±5.74
Initial weight /g	9.23±1.01	9.42±0.95	9.28±2.20
Final weight /g	36.96±3.21	50.48±2.91	54.23±3.22

Figure I. Evolution of the number of leaves per treatment



MYCOTOXIN PREDICTION SERVICE AFRICAN DATA 2024-Q1 2025 AND THE THREATS IN AQUACULTURE NUTRITION

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Summary: Mycotoxin Prediction Service

Mycotoxin Threats in Animal Nutrition

In Aquatic Species - When Problems in Fish Start to Surface

In Brief Zearalenone (ZEN) toxicity and its influences on animals have been described in the literature since the 1920s. This nonsteroidal, estrogenic mycotoxin is produced by species of fungi from the Fusarium genus and often found on field crops and other raw materials used in production of human food and both terrestrial and aquatic animal feed. Almost 100 years ago ZEN caught the eyes of the scientific community largely due to its estrogenic properties which are attributed to its molecular similarity to the female hormone estradiol (Figure 1). The consequences of these properties were observed in pathologies of farm animals. Later, it was also described in game and wild animals in their natural environments and in relation to pathologies in humans. In most aquaculture practices, a close contact between the natural aquatic environment and the cultured animals exist, for example sea cages, lake hapas and coastal pond systems, populated by fed fish.

Table 1 - ZEN in compound aqua feed between the years 2016-220 (source: Biomin global mycotoxin survey)

Parameter	ZEN
Number of samples	207
% Contaminated samples	48%
% Above Risk threshold	18%
Average of positives (ppb)	78
Median of positives (ppb)	36
Maximum (ppb)	888

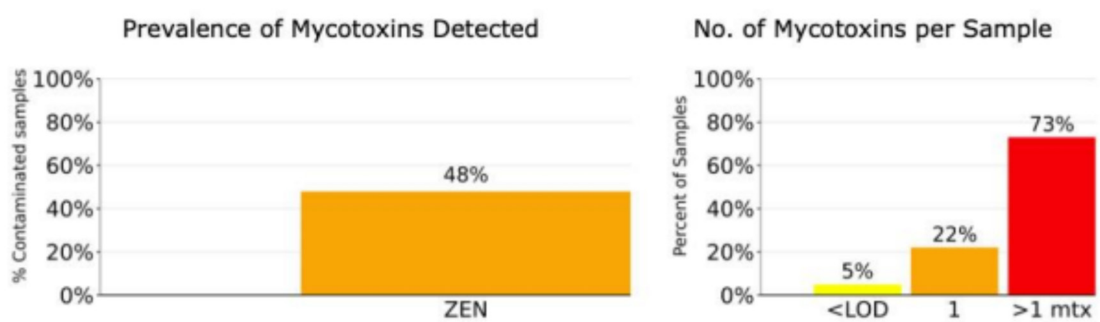

Figure 3 - Prevalence of ZEN and its co-occurrence with other mycotoxins in finished shrimp and fish feed between the years 2016-2020. (source: Biomin global mycotoxin survey)

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In addition, studies revealed that ZEN can enter natural aquatic environments via pasture and agricultural run-off water. Moreover, the toxin was also found in water and sediment originating from aquaculture. Understanding this agricultural-ecotoxicological relationship is an important step in making aquaculture a sustainable and responsible industry. The Biomin Mycotoxin Survey has revealed that ZEN is present in 48% of the >200 samples of finished-compound aqua feed that were analyzed between 2016 and 2020 (Table 1 and Figure 3).

Additional survey data on ZEN contamination in raw materials used in the aquaculture industry such as wheat, corn and corn product (like DGGS, gluten), soy, rice and more, strengthen the conclusion that ZEN is widely present and unnoticeably effecting the aquaculture industry. Table 1 - ZEN in compound aqua feed between the years 2016-220 (source: Biomin global mycotoxin survey) Parameter ZEN Number of samples 207 % Contaminated samples 48% % Above Risk threshold 18% Average of positives (ppb) 78 Median of positives (ppb) 36 Maximum (ppb) 888 Figure 3 - Prevalence of ZEN and its co-occurrence with other mycotoxins in finished shrimp and fish feed between the years 2016-2020. (source: Biomin global mycotoxin survey) Recognising and understanding ZEN in aquaculture

Recent data

dsm-firmenich underscores significant mycotoxin threats in animal nutrition, particularly affecting regions in Asia and the Americas. The comprehensive analysis involved 5,993 samples collected from 70 countries, revealing critical insights:
- Africa report Q1 2025 , 293 samples tested: 51% Zen and 86% DON.
- China and South Asia**: An alarming 94% of samples surpassed risk thresholds for at least one mycotoxin.
- Global Co-contamination**: 76% of samples were found to be co-contaminated with multiple mycotoxins.
- Prevalence of Mycotoxins**:
  - **Fumonisins (FUM)**: Detected in up to 99% of samples.
  - **Deoxynivalenol (DON)**: Found in 87% of samples.
  - **Zearalenone (ZEN)**: Present in 67% of samples.

Species and Regions at Risk

- **Species Most at Risk**: Swine, poultry, and aquaculture are particularly vulnerable.

Detection Methods

dsm-firmenich employs advanced technologies, **Spectrum Top®50** and **Spectrum 380®**, capable of detecting 50–800+ mycotoxins and metabolites, including masked and emerging threats.

This data highlights the urgent need for continuous monitoring and advanced detection methods to mitigate mycotoxin risks in animal nutrition across the globe.

THE EFFECT OF XALANASE , RONOZYME® WX, ON TILAPIA GROWTH WITH HIGH & LOW FISHMEAL DIETS

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Aquaculture plays a critical role in global food security, and optimizing nutrition is essential for enhancing fish health and growth performance. Arabinoxylans and xylans constitute the primary NSP fraction of cereals and their by-products. The used enzyme, an endo-1,4-β-xylanase (single enzyme product) degrades both the soluble arabinoxylans responsible for an increased viscosity, and the insoluble arabinoxylans, major cell wall constituents which entrap the proteins. Conclusions & Benefits: When adding the xylanase WX into a low fishmeal diet; growth was restored to a level seen with the high fishmeal FCR & Protein Efficiency were significantly improved.

Objective

- To evaluate the effect of the supplementation with a fungal xylanase (RONOZYME® WX) on growth performance and nutrient utilization in juvenile Nile tilapia (*Oreochromis niloticus*) fed cereals, cereals by-products and plant proteins with reduced fish meal level.

Methodology & Trial details

- Basal Diet: Wheat middling's, SBM, rapeseed, corn, rice bran, cottonseed meals, fishmeal (10% & 5%)
- Experimental: Initial body weight 25g, 12-week duration
- Treatments:
  - 6 treatment groups combining:
  - fishmeal (FM) at 10% and 5% in the diet
  - RONOZYME® WX supplementation at 0, 100 and 200 ppm
- Parameters: growth (body weight, weight gain, specific growth rate (SGR), FCR, protein efficiency ratio (PER), nutrient utilization after 9 & 12 weeks of feeding

Results:

- FCR was significantly correlated with the dietary dose of xylanase.
- Protein efficiency ratio (PER) was significantly increased with xylanase.
- No effect of the enzyme was observed on fat and energy retention.
- Protein retention was higher for FM 10% tha FM 5% one. Its increase was significantly correlated with the dietary xylanase dose.
- Nitrogen loss was reduced in relation to the enzyme dose.
- At 10% FM, the effective dose of xylanase was 100 FXU/kg feed.
- At 5% FM, most parameters were significantly increased at the dietary dose of 200 FXU/kg feed.

Conclusion:

- When xylanase was supplemented to a low fish meal diet, growth was restored to the level of the high fish meal control group.
- FCR & protein efficiency were significantly improved by dietary xylanase supplementation.
- Further improvement in performance and feed efficiency can be gained by supplementing a high fish meal diet with RONOZYME® WX.
- Dietary supplementation with the xylanase RONOZYME® WX is an effective tool to improve performance and feed efficiency of tilapia.

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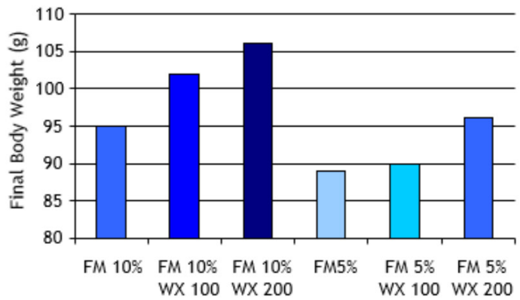
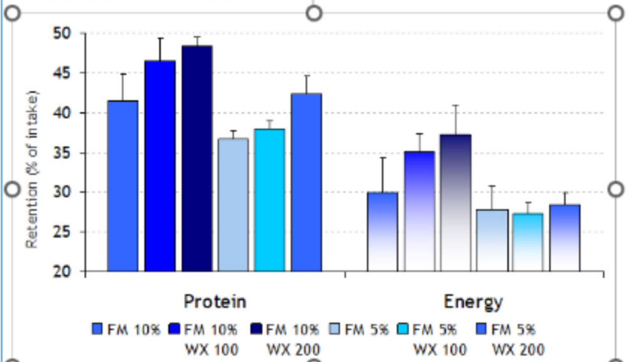
Results



12 weeks	FM effect	Enzyme effect
FBW	S	S
SGR	S	S
FCR	S	S
PER	S	S
Energy %	S	NS

Nutrient retention



AGE DETERMINATION AND GROWTH OF NILE TILAPIA (*oreochromis niloticus*) IN LAKE HAYQ, ETHIOPIA

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Age and growth of Nile tilapia, *Oreochromis niloticus* from Lake Hayq were studied from June 8, 2022 to June 7, 2023. A total of 738 otoliths were collected from the shore, open water and river mouth sites of the lake for otolith macrozone analysis. Otoliths were ground and examined under a dissecting microscope at 7−40X magnification for the presence of translucent and opaque macrozones using a reflected light source. The age of the fish was determined from the total number of translucent macrozones counted in the otoliths considering the time of translucent zone formation. The collected samples ranged from 9.3 to 32 cm in total length (TL) and from 14 to 495 g in total weight (TW). However of the fish sampled, 87.7 % were ≤ 13 cm. The maximum life span of *O. niloticus* was 6 years. A strong relationship between otolith length and otolith weight ($r^2 > 0.88$) was found in *O. niloticus*. The relationships between fish length and otolith (length) were ($r^2 > 0.92$). In *O. niloticus*, otolith weight was found to be best correlated with fish weight ($r^2 > 0.81$) and nearly the same correlation was discovered between otolith length and otolith weight. *Oreochromis niloticus* caught in Lake Hayq has asymptotic length ($L\infty = 31$ cm) and have a growth rate (k) 0.90/year, growth performance index (Ø′L =2.93 and scientific information related to growth parameters is one of the fundamental factors for population management in an aquatic area.

SMALL SCALE AQUACULTURE PRACTICES IN UGANDA: LESSONS TO PROMOTE AQUACULTURE DEVELOPMENT IN ETHIOPIA

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Small-scale aquaculture plays a crucial role in enhancing food security, nutrition, and livelihoods in Uganda. Uganda's fish production has significantly increased from 10,817 tons in 2005 to 138,558 tons in 2021, driven by 25,000 ponds and 5,000 cages, experiencing notable growth. This study examined key small-scale aquaculture practices in Uganda, with the aim of drawing lessons applicable to Ethiopia's aquaculture development, an aspiring key aquaculture player in Africa based on the need to launch aquaculture development insights of the blue economy initiative. The key farming practices and key players were identified based on existing practices, current annual production output and critical success factors to aquaculture development, thus used as a benchmark for Ethiopia. 340 small scale fish farms were selected based on criteria, and insights from field observations, interviews, and existing literature were used to identify key success factors and challenges faced by small-scale aquaculture operators. Aquaculture in Uganda is shaped by various factors that influence its productivity, sustainability, and profitability. The finding of this study revealed that the major factors include pond characteristics and management practices, cultured species; aquaculture production systems; availability and quality of fingerlings, pond size and stocking density, availability, quality and affordable feed, water sources and exchange rate, fertilization practices, disease management, market access and trade, provision of enabling environment through policies and frameworks, and climate and environmental factors. Despite Ethiopia's vast water resources, availability of native species and increasing demand for fish, the sector remains underdeveloped. Hence, this study identifies strategies that can enhance aquaculture sector in Ethiopia. Promoting fish seed production, local feed manufacturing, utilization of all water sources and exchange rate, pond size and stocking density, introduction of cage culture systems, strengthening value chains, and adopting best management practices from Uganda could significantly boost aquaculture productivity in Ethiopia. The study highlights the importance of enabling environment through policies and frameworks, stakeholder collaboration, and sustainable aquaculture technologies in fostering sectoral growth. As a result, lessons were derived to promote small scale aquaculture development in Ethiopia.

COMPARATIVE BACTERIAL COMMUNITY IN NILE TILAPIA GUT, SKIN MUCUS AND POND WATER IN EARTHEN PONDS OF UGANDA

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This study was conducted in Nile tilapia *(Oreochrois niloticus)* earthen pond farms to investigate the bacterial community composition in three sample types (gut, mucus, and water) collected from five distinct agroecological zones. Bacterial DNA was extracted using the Zymogen DNA Mini Kit, with quality control performed using gel electrophoresis and the Nanodrop spectrophotometer to assess DNA integrity and concentration. High-throughput sequencing was carried out using the Illumina MiSeq platform to generate 16S rRNA gene amplicon data. Bioinformatics processing, was conducted using QIIME2 while visualization and statistical analysis was conducted in R package. Utilizing both alpha and beta diversity analyses, we explored the bacterial differences and similarities within and between these sample types across varying environmental conditions. Alpha diversity analysis revealed that mucus has the highest diversity of bacteria while there is significant difference between water and gut samples, no difference observed between water and mucus and gut with mucus samples. No significant difference was observed in bacterial community diversity across agroecological zones. Alpha diversity metrics indicated higher within-sample similarity for both water and gut samples, while mucus samples displayed greater variability in microbial composition. Principal Coordinates Analysis (PCoA) revealed clear separation between gut and water samples, indicating distinct bacterial communities in each environment, while mucus samples exhibited intermediate positioning, suggesting a transitional microbial community with characteristics shared between gut and water. The first two principal axes of PCoA explained 17.6% of the total variation, highlighting significant compositional differences across the sample types and agroecological zones. These findings provide insights into the ecological dynamics of bacterial communities in host-associated and environmental habitats, suggesting microbial gradients and shared taxa between different environments across diverse agroecological zones.

BIOREMEDIATION, WASTE TREATMENT AND CARBON CAPTURE USING BIOENGINEERED MICROBES FOR SUSTAINABLE AQUACULTURE

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Aquaculture is a rapidly growing sector facing challenges related to environmental pollution, waste management and carbon emissions. This study explores the application of bioengineered microbes for bioremediation, waste treatment and carbon capture to enhance sustainability in aquaculture systems. Microbial biotechnology offers promising solutions for mitigating environmental risks associated with intensive fish farming and marine cultivation.

Bioremediation for Aquaculture Waste Management – Bioremediation utilises microbial consortia to degrade organic waste, heavy metals and hydrocarbons in aquaculture environments. Specific strains of bacteria and fungi can break down nitrogenous waste, reducing ammonia and nitrate toxicity in fish farms. Field studies have demonstrated a 40% reduction in toxic contaminants in marine aquaculture facilities using engineered microbial solutions.

Microbial Waste Treatment and Recycling – Efficient waste treatment is crucial for maintaining water quality in aquaculture. Engineered microbial systems enhance the breakdown of fish waste, feed residues and organic sludge. This study examines the use of biofloc technology, where microbial biofilms recycle nutrients, reducing water exchange requirements by 60%. Additionally, microbes facilitate the conversion of organic waste into biofertilizers, supporting circular economy practices in aquaculture.

Carbon Capture and Utilisation – The integration of bioengineered algae and bacteria in aquaculture systems provides a dual function: carbon sequestration and biomass production. Cyanobacteria and microalgae can absorb atmospheric CO2, aiding in climate change mitigation. Experimental data indicates a 30% increase in CO2 capture efficiency when incorporating genetically modified algal strains in aquaculture ponds. The captured carbon is further utilised to produce sustainable bioproducts, such as biofuels and bioplastics, reducing the environmental footprint of fish farming.

In summary, the application of bioengineered microbes in aquaculture presents a sustainable approach to mitigating pollution, improving waste recycling and enhancing carbon capture. Future research should focus on optimizing microbial consortia for large-scale deployment and ensuring regulatory compliance in various aquaculture settings. Adopting microbial biotechnology could significantly enhance the sustainability of global aquaculture, contributing to environmental conservation and improved food security.

Table 1. Summary of Biotechnological Applications in Aquaculture

Application	Microbial Approach	Environmental Benefit
Bioremediation	Bacteria & fungi	Reduces toxic waste
Waste Recycling	Biofloc systems	Enhances nutrient cycling
Carbon Capture	Algae & cyanobacteria	Mitigates CO2 emissions

Figures and experimental results supporting these findings will be presented in detail at the conference.

CONCEPT OF INDEPENDENT QUALITY CONTROL OF VETERINARY VACCINES IN AFRICA

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The concept of independent quality control of veterinary vaccines in Africa started in the early 1980s as a prerequisite for funding the Pan-African Rinderpest Campaign (PARC). The international audit carried out by the Food and Agriculture Organization of the United Nations (FAO) in 1983 on the quality of rinderpest vaccines produced in Africa revealed serious quality deficiencies. According to the audit, **only 20%** of the vaccines produced by African laboratories met acceptable **quality standards**. To support the PARC, two regional training and vaccine quality control centers (Debre-Zeit, Ethiopia and Dakar, Senegal) were then established in 1986 which later were merged and became the Pan-African Center for Veterinary Vaccines. In recognition of the important role played by PANVAC in the eradication of rinderpest in Africa, the 67th Ordinary Session of the OAU Council of Ministers (Addis Ababa, February 23-27, 1998) decided to elevate PANVAC to the rank of OAU Specialized Agency. On March 12, 2004, the Center was officially launched as a Regional Center of the African Union, headquartered in Debre Zeit (Ethiopia) under the Department of Agriculture, Rural Development, Blue Economy and Environmental Sustainability (ARBE), with the mission to “promote the use of good quality vaccines and reagents for the control and eradication of animal diseases in Africa”. The main objective of the AU-PANVAC has been to promote quality improvement, achieve uniformly of standards for production and quality control of veterinary vaccines. Whereas only two types of vaccine were tested in the 80s and 90s, AU-PANVAC currently tests over 50 types of vaccine from Africa and overseas. The vaccine quality has risen considerably, from 20% in the 80s to around 90% today. AU-PANVAC has been designated as a Collaborating Center of the World Organization for Animal Health (WOAH) and a Reference Center for Vaccine Quality Control by the FAO. A New Laboratory complex is under construction with the support of the U.S. Defense Threat Reduction Agency’s Biological Threat Reduction Program (DTRA/BTRP).

The Center has launched the process of harmonizing standards for veterinary vaccine registration and to develop a guideline for audit and certification of vaccine manufacturers. It is also working to assure the quality control of aquatic animal vaccines, and to contribute to the establishment, with WOAH, of a standard to control the safety and efficacy of these vaccines. Fish vaccines can be administered by injection, immersion or orally; and a variety of vaccines are available.

GUIDING SUSTAINABLE AQUACULTURE PRACTICES: BENTHIC BIODIVERSITY INSIGHTS FROM LAKE VICTORIA, KENYA

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Lake Victoria, the world's largest tropical lake, is a vital ecological and economic resource shared by Kenya, Uganda, and Tanzania. The lake supports millions through fishing, agriculture, and increasingly, aquaculture. In response to declining capture fisheries and rising protein demand, cage aquaculture has expanded rapidly. While economically beneficial, this practice raises ecological concerns, particularly regarding its impact on benthic biodiversity.

This study assessed the effects of cage farming on benthic macroinvertebrate communities across five sites—Dunga, Naya, Ndere Island, Sena, and Rasira—representing both aquaculture and non-aquaculture zones. Using Ekman grab samplers, sediment samples were collected and analyzed for species composition, abundance, and diversity. Water quality parameters, including temperature, dissolved oxygen, pH, turbidity, and nutrient concentrations (nitrogen and phosphorus), were measured in situ and in the laboratory. Data analysis employed the Shannon-Weaver Diversity Index and the Hilsenhoff Biotic Index (HBI) to evaluate biodiversity and organic pollution levels.

Findings revealed that areas near cage farms exhibited reduced benthic diversity and increased abundance of pollution-tolerant species, such as Chironomus tentans and Tubifex tubifex. Elevated nutrient levels from fish waste and uneaten feed led to eutrophication, algal blooms, and hypoxic conditions, adversely affecting sensitive benthic taxa. Notably, Naya and Ndere Island, with fewer cage installations, recorded higher taxonomic richness compared to heavily farmed sites like Sena and Rasira.

The study underscores the need for sustainable aquaculture practices that mitigate environmental impacts. Recommendations include strategic site selection away from ecologically sensitive areas, regular monitoring of water quality and benthic communities, and implementation of best management practices to reduce nutrient loading. Such measures are crucial to balance the economic benefits of cage farming with the preservation of Lake Victoria's ecological integrity.

BALANCING AQUACULTURE DEVELOPMENT AND BIODIVERSITY: HYBRIDIZATION STUDIES OF TILAPIA SPECIES IN KISII, KENYA

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Lake Jipe, straddling the Kenya-Tanzania border, is experiencing significant ecological degradation due to climate change, habitat modification, pollution, and the introduction of non-native species. These factors have critically endangered the endemic Jipe tilapia (*Oreochromis jipe*), which has a restricted range and declining populations. Notably, the introduction of *O. niloticus* and *O. esculentus* has led to the displacement of *O. jipe* and potential hybridization, threatening its genetic integrity.

This study investigates the hybridization potential of *O. jipe* with introduced tilapia species under controlled aquaculture conditions. A total of 144 mature brooders (100–120g) were randomly selected and paired in a 1:2 male-to-female ratio across different combinations: *O. niloticus* (♀) × *O. niloticus* (♂), *O. niloticus* (♂) × *O. jipe* (♀), *O. jipe* (♂) × *O. niloticus* (♀), and *O. jipe* (♂) × *O. jipe* (♀). Fish were fed a 35% crude protein diet at 5% of their body weight daily, divided into three feeding sessions. After 28 days, fry were counted and reared separately based on their cross type.

Findings revealed that pure lines of *O. esculentus*, *O. niloticus*, and *O. jipe* spawned by day 28, while crosses between *O. esculentus* and *O. niloticus* spawned by day 34. Crosses involving *O. jipe* and *O. niloticus* took longer to spawn and produced fewer offspring, suggesting that *O. jipe* may hybridize under stress. Growth performance varied among the different crosses, with no consistent weight gain patterns observed. Morphological differences were noted among fingerlings, but gender identification at this stage was challenging.

The study concludes that *O. jipe* can hybridize with introduced species under controlled conditions, and the hybrids can survive in aquaculture settings. However, the reproductive viability of these hybrids remains to be ascertained. Understanding these dynamics is crucial for developing conservation strategies, and controlled aquaculture of *O. jipe* and its hybrids could serve as a conservation tool, provided that measures are taken to prevent unintended genetic mixing in the wild.

WATER QUALITY ANALYSIS FOR DEVELOPING A SANITARY MANAGEMENT PROTOCOL IN A MARINE HATCHERY IN ALGERIA

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Marine aquaculture in Algeria is expanding rapidly, requiring robust health management practices to ensure sustainable and productive operations. This study aims to assess the microbiological and physicochemical quality of water in a marine hatchery rearing European seabass *Dicentrarchus labrax* and gilthead seabream *Sparus aurata*, with the goal of designing an effective sanitary management protocol. Water samples were collected from key locations within the hatchery system, including the seawater intake, storage tanks, and broodstock rearing units. Physicochemical parameters such as temperature, salinity, dissolved oxygen, and nutrient concentrations (NH_4^+, NO^{2-}, NO^{3-}, PO_4^{3-}) were measured using a multiparameter probe and segmented flow analysis (Auto analyser). Microbiological analyses targeted indicator bacteria (coliforms, streptococci) and potential pathogens (e.g., *Staphylococcus aureus*, *Vibrio* spp.) using membrane filtration on selective media. Preliminary results revealed elevated ammonium levels and the presence of *Staphylococcus aureus*, suggesting inefficiencies in biofiltration and UV disinfection. This study highlights the critical role of continuous water monitoring in marine hatcheries and presents practical insights for the implementation of sanitary protocols aimed at improving larval survival and hatchery biosecurity.

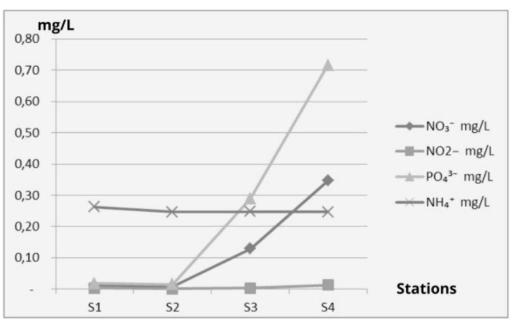

Figure 01: Variations in average concentrations of nutrient salts at different stations

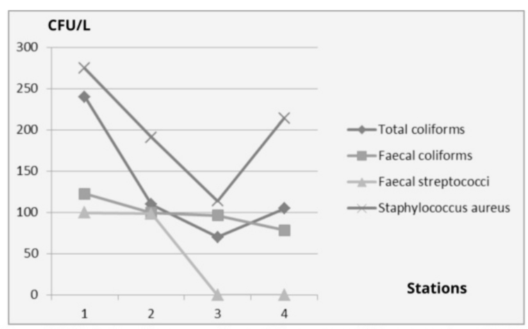

Figure 02: Variations in average bacterial counts at different stations (CFU/L)

ECOLOGICAL ASSESSMENT OF WATER QUALITY IN FISHPONDS INTEGRATED INTO COCOA PLANTATIONS IN CÔTE D'IVOIRE: INSIGHTS FROM BIOMARKERS ANALYSES

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Facing the need to diversify income sources due to declining productivity in cocoa plantations, cocoa farmers in Côte d'Ivoire are increasingly adopting aquaculture as an additional revenue stream, establishing fishponds in low-lying areas adjacent to or within their farms. Given the intensive use of chemical agricultural inputs in cocoa cultivation, this study aims to evaluate the ecological quality of water in fishponds integrated into cocoa farming systems using biomarkers analyses. Aquatic macroinvertebrates and microalgal flora were used as biological indicators to assess water quality in 6 fishponds integrated into cocoa plantations across two regions in Côte d'Ivoire: Méagui and Sinfra.

Water parameters were measured with a multiparameter probe. Ammonia (NH3) and phosphate (PO_4^{3-}) levels were analysed with a photometer, while transparency was assessed via Secchi disk. Phytoplankton and macroinvertebrates were sampled using nets and sediment grabs. Water quality was evaluated using biotic indices, including Shannon diversity, Pielou's equitability, biosedimentary index (IBS), planktonic index (IP), and macroinvertebrate families sensitivity to pesticides.

Results from physicochemical analyses indicate acceptable water characteristic for aquaculture. While, Shannon diversity and Pielou equitability indices from both algae and macroinvertebrates communities and also Biosedimentary Index (IBS) (4,6-5,46) classified water quality as marginal to poor.

Moreover, the Plancton Index (38-108) indicates average to poor ecological status of water. Macroinvertebrates families sensitive to pesticides were scarce (0–20%) in the whole ponds.

The integration of fishponds into cocoa agroecosystems presents economic opportunities but raises ecological concerns due to pesticide runoff. The prevalence of pollution-tolerant species and low proportions of sensitive macroinvertebrates underscore the cumulative impacts of agrochemical use. To mitigate risks, farmers should adopt integrated pest management strategies and explore organic alternatives to synthetic inputs.

Acknowledgement: The authors would like to thank the IRN ASACHA-IRD for sustain participation to WAS and D. Caruso from IRD for facilitation and advice.

Table. Values of biotic indices for ponds water quality analysis. IBS; Biosedimentary index; H': Shannon diversity index; J': Pielou Equitability index; PI: Plankton Index; MG: Meadji pond; SF: Sinfra pond

Biomarkers	Indices	Méadji			Sinfra		
		MG1	MG2	MG3	SF1	SF2	SF3
Macro invertebrates	H'	2.00	1.95	2.20	2.31	2.38	2.62
	J'	0.72	0.88	0.76	0.87	0.86	0.89
	IBS	4.6	4.83	5.6	4.6	5.4	5.16
phytoplankton	H'	2.32	1.24	3.63	3.63	2.12	3.47
	J'	0.77	0.44	0.89	0.93	0.71	0.82
	PI	52	38	108	76	76	52

Figure. Proportions of macroinvertebrates in ponds according to their sensitivity to pesticides. SP : sensitive to pesticides ; Non-sensitive to pesticides ; MG : Méadji ponds ; SF : Sinfra ponds

EFFECTS OF TEMPERATURE AND SALINITY ON THE GROWTH AND PATHOGENICITY OF *Edwardsiella ictaluri,* AN EMERGING PATHOGEN OF TILAPIA (*Oreochromis* sp.)

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Edwardsiella ictaluri has recently emerged as a significant pathogen responsible for high mortality rates in cultured tilapia. However, the relationship between disease outbreaks and environmental conditions remains poorly understood. This study examines the growth capacity and pathogenicity of *E. ictaluri* under varying temperature and salinity conditions. Three bacterial isolates obtained from diseased tilapia were used in in vitro growth experiments, followed by challenge tests using an LD70 bacterial dose to assess pathogenicity in tilapia. The results indicate that *E. ictaluri* exhibits optimal growth at temperatures between 25°C and 30°C, with significantly reduced growth at 15°C, 20°C, and 35°C. Optimal bacterial growth occurred at salinities of 0–5‰, while growth declined sharply at 10‰, 15‰, and 20‰, with no viability detected at salinities of 25‰ or higher. Challenge experiments demonstrated that *E. ictaluri* induced Edwarsiellosis within a temperature range of 17.5°C to 27.5°C, with the highest mortality rates recorded at 20°C and 25°C. In comparison, dead or dying fish accounted for significantly lower mortality rates at 17.5°C and 27.5°C. Clinical signs were most severe at 25°C and 27.5°C, moderate at 20°C, and mild at 17.5°C. Regarding salinity, the pathogen caused disease across all tested levels, with 100% mortality observed at 15‰ and 20‰, reduced mortality at 0‰ and 5‰, and the lowest mortality rate at 10‰. Lesion severity was highest at salinities of 0–10‰, moderate at 15‰, and mild at 20‰. These findings provide critical insights into the environmental factors influencing *E. ictaluri* outbreaks, contributing to developing effective strategies to control tilapia disease.

LETHAL AND NON-LETHAL CONCENTRATION OF ETHANOL EXTRACT OF *Tribulus terrestris* ON CATFISH *Clarias gariepinus*

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Tribulus terrestris is believed to affect the biological functions of fish. Its effects may differ based on the dosage, which has yet to be established for *Clarias gariepinus*. This study aimed to identify the lethal (LC_{50}) and the non-lethal concentration of ethanol extract from *Tribulus terrestris* on fry of catfish (*Clarias gariepinus*). A 96-hour acute toxicity assessment of the ethanol extract was conducted using Probit analysis. The non-lethal concentration of the ethanol extract of *Tribulus terrestris* was determined based on the LC_{16}, LC_{50}, and LC_{84} values derived from the response curves for exposure durations of 6, 12, 24, and 48 hours (Figure 1). The LC_{50} values were recorded as 9.34 mg/L, 5.95 mg/L, 5.43 mg/L, 3.16 mg/L, 3.16 mg/L, and 3.16 mg/L for the exposure durations of 6, 12, 24, 48, 72, and 96 hours, respectively (Table 1). A non-lethal concentration of 1.4 mg/L was established from the LC_{16}, LC_{50}, and LC_{84} data (Figure 1). These findings suggest that as *Clarias gariepinus* are exposed to the ethanol extract of *Tribulus terrestris* for an extended duration, a smaller concentration of the extract is sufficient to lethally affect 50% of the population. Therefore, concentrations of 1.4 mg/L or less of the ethanol extract of *Tribulus terrestris* are considered non-lethal to catfish *Clarias gariepinus*.

Table 1: Acute toxicity values of *Clarias gariepinus* exposed to concentrations of ethanol extract of *Tribulus terrestris* during a 96hr acute toxicity studies (each concentration tested with 10 fry in triplicate)

Exposure period (hr)	LC_{50} (mg/L)	95% Fiducial limits Lower (mg/L)	95% Fiducial limits Upper (mg/L)	LC_{16} (mg/L)	LC_{84} (mg/L)	Slope function (S)	95% CL
6	9.34	6.43	13.57	3.29	26.56	2.8423	1.4529
12	5.95	4.19	8.46	2.23	15.91	2.6733	1.4214
24	5.43	4.11	7.16	2.10	14.00	2.5799	1.3188
48	3.16	2.64	3.79	1.71	5.87	1.8544	1.1976
72	3.16	2.64	3.79	1.71	5.87	1.8544	1.1976
96	3.16	2.64	3.79	1.71	5.87	1.8544	1.1976

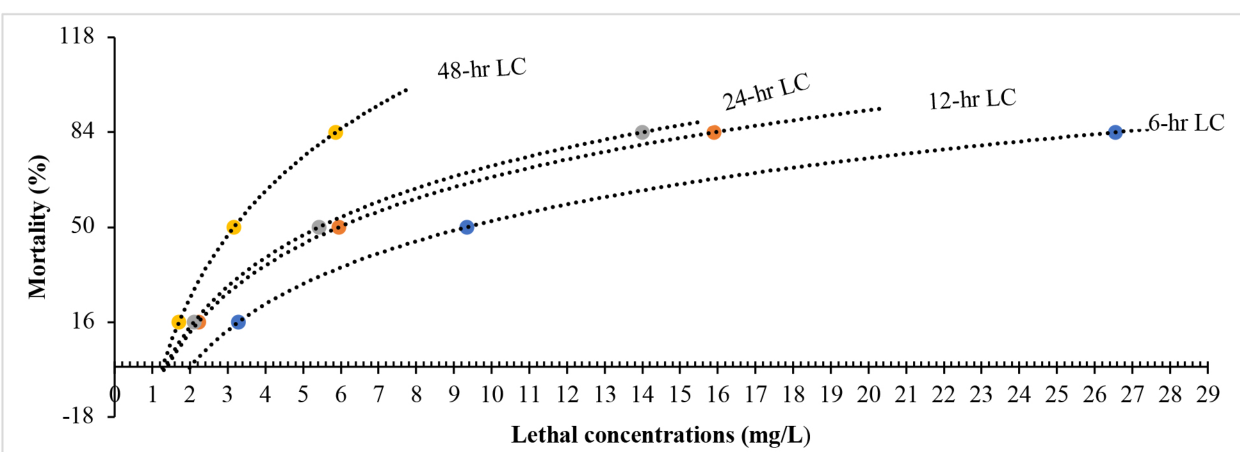

Figure 1: Non-lethal concentration of ethanol extract of *Tribulus terrestris* in *Clarias gariepinus* exposed to a 96hr acute toxicity study.

NON-STARCH POLYSACCHARIDES PROMOTES POND PRODUCTIVITY AND NILE TILAPIA YIELDS UNDER VARIED REDFIELD RATIOS (C:N:P)

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About a decade and a half ago, Nile tilapia was majorly (about 80%) raised in earthen ponds. However, due to the poor nutrient recycling in fishponds leading to poor water quality, coupled with other factors such as fish diseases, causing fish mortalities, poor fish yields and heavy financial losses, many farmers are abandoning the ponds and leaving the business. The nutrients of concern are nitrogen(N), phosphorus (P), and carbon(C) from the highly nitrogenous waste feed materials. Water exchange, the commonly practiced water quality control measure, is being constrained by water supply shortage in the Agro-ecological zones throughout the production cycle. Recent studies have demonstrated a potential water saving control method which involves use of high carbon to nitrogen (C/N) diets with the dietary carbon sourced from the high profile insoluble-NSPs products such as Baggase, rice bran etc. The diets being low in nitrogen, lowers the level of nitrogenous wastes, and increases the pond C/N levels. An increase in pond C/N ratio above 10, promotes the growth of specific live food organisms that utilize the pond organic wastes improving pond water quality, and reducing the need for water exchange. In this study therefore, we will test the effect of dietary C:N:P ratios in tilapia-formulated feeds by exploring the use of the locally available NSP-rich food stuffs on pond productivity, water quality and fish production.

Methods: Four test diets having two test NSP-products combinations e.g., i). *Baggase, Palm oil kernel, sunflower seed cake,* and ii). *Baggase, Coffee husks, Rice bran,* at two C/N ratio i.e., (i.e., <10, and >10) will be formulated and used, with the standard commercial tilapia diet (C/N = 8) as the control diet. All-male juvenile Nile tilapia will be used. The trial will be conducted in 15 hapas of 20 m^3 (5 x 4 x 1 m) fixed in five 200 m^2 ponds. A cost benefit analysis will be conducted to determine economic benefits.

Expected Results: NSPs composition of the locally available plant material determined and profiled. Best performing NSPs food-stuff (s) identified. A suitable cost-effective diet(s) (i.e., dietary C:N:P ratio(s)), that best promote pond nutrient recycling, improving water quality, N. tilapia yields, and profitability determined.

Conclusions: The project is expected to improve on pond nutrient recycling by promoting growth of specific live food organisms that utilize the pond nutrients, promoting good pond water quality, and Nile tilapia production.

INNOVATIVE SOLUTION TO TACKLE THE EXISTING CHALLENGES ON AQUACULTURE FOR BLUE ECONOMY DEVELOPMENT IN TANZANIA

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Tanlapia in-pond raceway system (IPRS) as an innovative solution for aquaculture production in Tanzania

Tanlapia IPRS Case Study
For Tanzania to fully utilize the potential available in Blue Economy and become the leading provider of fish and 'aquatic food products' in East and Central Africa, and to grow and shape the market in the region there is a need of exploring and investing in innovative technology.

Tanlapia Limited, a private owned company operates large-scale commercial tilapia farm in Bagamoyo along the Ruvu river catchment. It is the largest land-based fish farm in operation since 2020. Realizing the available potential and challenges facing the aquaculture industry in Tanzania, Tanlapia Limited decided to invest in Tilapia Fish Farming by adopting the state-of-the-art fish production system known as In Pond Raceway System (IPRS). This is a super- intensive production system inverted by the University of Auburn through the support of USSEC (United State Soy Export Council).

In-Pond Raceway Systems are an advanced approach to pond aquaculture that combines the management benefits of confining fish in a small portion of the pond with the production capacity of a flowing water system. IPRS creates a flowing "river in the pond" and allows the water to mix and move as it would in a riverine system. This flowing water significantly increases the pond's production potential.

Advantages of IPRS
This system lowers per unit production costs, reduces risk and significantly improves yield. IPRS operate with simplicity and in harmony with nature to offer greater predictability and profit potential than conventionally operated ponds. The IPRS technology offers the potential to double, or even triple, yields beyond traditional pond expectations (up to 70-80 tons per hectare in tropical climates) with no discharge of water or waste into local waterways. the system does not echange water as is the case in convertional semi intensive pond aquaculuture, making the IPRS technology ideal in adapting to climate change impacts. IPRS is a more manageable, controllable approach allowing high yields and reduce environmental impact.

Alignment of IPRS to Blue Economy Objectives
IPRS technology is therefore, in line with Blue Economy which seeks to promote economic growth, responsible production and consumption, social inclusion, preservation and improvement of livelihoods while at the same time ensuring environmental sustainability of ecosystems. The technology offers a promising diversification option, especially in a time when markets are becoming increasingly demanding, production costs are rising, and finished product prices remain low.

LEVERAGING COOPERATIVES TO TRANSFORM AQUACULTURE IN UGANDA

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Current statistics indicate that Uganda's fish production has been steadily increasing, with total production reaching approximately 690,000 tons in 2020. However, the demand for fish protein remains high, with an estimated annual requirement of 1.7 million tons to meet both domestic consumption and export needs. This highlights a significant production deficit, which can't be fulfilled sufficiently by capture fisheries presenting a substantial opportunity for growth in the aquaculture sector.

Aquaculture has emerged as a vital sector for enhancing food security, economic development, and sustainable livelihoods in Uganda. However, the potential of aquaculture is often hampered by various challenges such as limited access to resources, technical knowledge, and market opportunities. Cooperatives, community-based organizations, offer a promising solution to these challenges. By leveraging collective resources, knowledge, and efforts, cooperatives can play a pivotal role in promoting and sustaining aquaculture in Uganda. Interested farmers, particularly women and youth, often face constraints such as limited land ownership, high costs of quality inputs, insufficient extension and technical support, market access challenges, including processing and value addition. Cooperatives provide an avenue to receive training Department of Industrial Training (DIT) certification, business accreditation, access to communal resources like land, quality inputs, and market access.

By operating as a business, cooperatives can achieve economies of scale, enhance productivity, and secure better market opportunities. Furthermore, the integration of technology within cooperatives enhances their effectiveness. Digital tools for record-keeping and tracking cooperative activities streamline operations and improve transparency. Technology enables real-time support and data-driven decision-making, ensuring timely interventions and optimizing aquaculture practices. Harnessing the power of data is crucial to monitor cooperative activities and improve overall performance of aquaculture farms.

We therefore show here how knowledge transfer through structured training programmes, supply of quality inputs and formation of fish farming cooperatives can enhance the engagement of all facets of communities in growing aquaculture production among the marginalized.

EXPERIENCES FROM DIFFERENT CONTINENTS WORKING WITH SEVERAL THOUSANDS OF AQUACULTURE VALUE CHAIN STAKEHOLDERS

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In an era marked by geopolitical instability, climate shocks, and disrupted trade routes, the global feed industry especially aquafeed faces structural transformations. Gianluigi Negroni's eight main chapters explores how these external pressures are reshaping protein supply chains, ingredient sourcing, and feed formulation strategies in 2025 and beyond. The narrative begins by identifying how trade fragmentation, conflicts, and rising shipping costs have endangered access to key feed ingredients such as fishmeal, soybean meal, and cereals. These disruptions have especially impacted producers in import-reliant regions like Africa, Asia, and Latin America. Amid this volatility, the need for feed reformulation and localized production has intensified. Additional details of available ingredients for the local Ugandan aquaculture feed production are highlighted in this paper, they were collected during PESCA project (2021-2024).

The paper highlights the growing risk of fraud and adulteration in protein ingredients due to weak regulatory enforcement and strained supply chains. It advocates for more stringent traceability, digital compliance systems, and blockchain-based sourcing to ensure transparency and restore consumer trust. Resilience, the author argues, is not just a response to risk, but a strategic advantage. Emerging models of smart decentralization are discussed, with a focus on developing regional feed hubs that use local agro-industrial by-products, insect protein, wild Victoria Lake available ingredients (micro shrimp, water hyacinth and lake fly) and algae. Circular economy principles and technological innovation (e.g., AI-driven quality control, remote auditing, fermentation technologies) are framed as key enablers of sustainability and security. The articles examine global vulnerabilities like the strategic dependency on maritime chokepoints such as the Suez and Panama Canals which, if disrupted, can send feed prices skyrocketing. This situation affected Uganda for some times during COVID 19 period. This further supports the urgency to diversify sourcing and invest in alternative protein production closer to consumption zones. The paper highlights the importance of non-conventional, locally sourced ingredients and circular feed models for protein security, particularly in emerging markets driven by global demand growth for meat and fish. The US and China, both major players, are influenced by these markets. Ultimately, Negroni and his Ugandan group of specialist and companies calls for coordinated action between industry, regulators, and researchers to build a resilient, ethical, and transparent global feed system capable of withstanding geopolitical and environmental upheavals.

FROM FARM TO PLATE: ENHANCING TILAPIA HEALTH AND WELFARE THROUGH ONE HEALTH INNOVATION

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Tilapia aquaculture is vital to food security, nutrition, and income generation, especially in developing regions. However, the intensification of production systems presents growing challenges to fish health and welfare. Poor welfare conditions often driven by parasite infestations, environmental stressors, and inadequate husbandry undermine productivity, compromise biosecurity, and pose risks to public trust and ecosystem stability. This study applies a One Health approach to identify sustainable, welfare-conscious strategies for managing fish health in tilapia aquaculture. By linking aquatic animal welfare, environmental stewardship, and human well-being, One Health offers a holistic framework for disease surveillance and response. This trial experiment focused on validating a non-lethal, ethical method for the detection of *Gyrodactylus* species, common parasitic threats in both wild and farmed tilapia populations. A controlled trial was conducted to compare the effectiveness of a hydrogen peroxide bath treatment (560 ppm for 3 minutes) against a traditional lethal treatment using 2-phenoxyethanol (0.15–1.2 mL/L). Sixty tilapia were sampled, targeting an expected mean parasite prevalence of 20%. Parasites were recovered and preserved in ethanol, then identified through morphological screening and High-Resolution Melting (HRM) molecular analysis. Sensitivity was assessed by the likelihood of detecting at least one parasite per infected fish. Statistical comparisons (ANOVA, t-tests, or non-parametric methods) were used to evaluate detection efficacy, time, and cost efficiency. Results confirmed that the hydrogen peroxide method successfully recovered parasites while preserving fish life, offering a viable and welfare-friendly alternative for routine surveillance. This approach supports early disease detection, reduces the need for antibiotics, and aligns with international standards for ethical aquaculture practices. Integrating non-lethal diagnostic methods into fish health monitoring protocols can significantly enhance disease management while upholding fish welfare. The study recommends adoption of One Health-aligned surveillance systems across tilapia production systems, supported by stakeholder training and policy development. By embracing innovative and ethical tools, the aquaculture sector can strengthen sustainability, improve consumer confidence, and protect the interconnected health of fish, people, and the environment.

IMMUNOPROTECTION OF NILE TILAPIA (*Oreochromis niloticus*) AGAINST *Edwardsiella tarda* INFECTION IN UGANDA

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Edwardsiella tarda is a gram-negative bacterium belonging to the family Enterobacteriaceae, it is the causative agent of edwardsiellosis a disease which is among the major constraints in aquaculture worldwide. It causes mass mortalities of fish that results into high economic losses in both aquaculture and fisheries.

This study aimed at determining the immunoprotection of Nile tilapia against *E. tarda* infection. A total of 50 fish in five groups were used to determine the LD_{50}, fish were exposed to *E. tarda* intraperitoneally by injection with dilutions $1.5x10^6$ to $1.5x10^9$. In the second phase, two groups of 20 fish each were vaccinated with formalin-killed *E. tarda* and phosphate buffered saline for control; a booster dose was given two weeks after the first dose. Blood was collected weekly from six fish in each group for serum to determine antibody titer by agglutination in microtiter plates. Two weeks after the booster dose, all fish were challenged with 100µl of 10^8 CFU/ml *E. tarda* (LD_{50}). Fish were monitored for four weeks; dead fish were recorded, examined for clinical signs and pathological changes. Bacteriology was done to confirm the presence of the pathogen in freshly dead or moribund fish. Bacterial load in the liver kidney and spleen was determined by drop plate counting from 10-fold serial dilutions of homogenized tissues. LD_{50} of $1.6x10^8$ was determined in this study.

Infected fish showed signs of skin and fin hemorrhages, ulcers, depigmentation, exophthalmia, erosion and distended abdomen on the external parts while grayish nodules in the spleen, kidney, congested internal organs, fluid filled intestines, black spots in the liver, mottled liver were observed in the internal body part. These lesions were more severe in the non-vaccinated groups. All the sampled dead fish were *E. tarda* positive which was confirmed using API 20E kits. Significantly high antibody titers were found in vaccinated fish and the Relative Percentage Survival was 32.4% indicating relative protection. The bacterial load was significantly higher in the kidney than in the liver and spleen in non-vaccinated than in vaccinated fish, antibody titers in the vaccinated fish were highly significant than in non-vaccinated ($p<0.05$).

Results indicate that formalin-killed cells enhance production of specific antibodies, induce specific immunity and can confer protection to the fish. These results can be used as a baseline for vaccine development after a series of studies on different age groups of fish and doses of different formulations of vaccines under optimized conditions.

GENDER-BASED VULNERABILITY AND ADAPTATION TO SMALL PELAGIC FISHING REGULATIONS ON UGANDA’S GREAT LAKES

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Fisheries resources are critical for global food and nutritional security, especially in developing countries where fishing contributes greatly to economic stability and food security. To ensure the sustainability of these resources, fisheries management develops policies and regulations aimed at long-term conservation and protection of these resources. In Uganda, a ban on the “hurry-up” fishing method for small pelagic fishes such as Mukene (lake sardine) was launched in 2024 and implemented on the main producing lakes of Victoria, Kyoga, and Albert. Although the ban aimed to reduce bycatch of the economically valuable Nile perch, its abrupt implementation and enforcement had substantial impacts on the livelihoods of fishing communities. This study seeks to 1) examine how the method closure differently impacts men and women, 2) assess the adaptive capacity and adaptive strategies of individuals in the Mukene fishing sector; and 3) identify alternative management strategies for small pelagic fisheries in Uganda’s major lakes. We will use a mixed-methods approach to analyse the livelihood impacts of the ban, to investigate conflicts with other fishery sectors that prompted regulatory changes, and to evaluate adaptive approaches that can lead to positive and equitable livelihood outcomes for fishing-dependent households faced with governance-related shocks. Data will be collected through key informant interviews with fisheries managers, focus group discussions with members of other fishery sectors (e.g. Nile perch), and household surveys with men and women engaged in the Mukene fishery. We predict that women will experience greater food insecurity and economic instability as a result of the gear ban compared to men, and that they will also have lower adaptive capacity given their restricted access to factors that can promote adaptive capacity. Ultimately, this research will inform management strategies that balance Nile perch fishery sustainability with the needs of vulnerable groups, supporting more equitable governance across Uganda’s major fishing lakes.

EXPLORING *Enteromius* SPECIES (PISCES: CYPRINIDAE) DIVERSITY THROUGH BARCORDING IN SMALL WATER BODIES WITHIN THE NORTH RIFT REGION, KENYA

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Aquatic ecosystems, particularly those in the North Rift region of Kenya, harbor diverse *Enteromius* species of the Cyprinidae family. These species exhibit significant genetic diversity and distinct population structures, yet their widespread distribution in rivers and reservoirs across Africa poses challenges, including loss of genetic diversity and population instability. Many populations remain unidentified, highlighting the urgency for comprehensive biomonitoring efforts. This study was carried out to identify *Enteromius* species using morphomeristic characteristics and barcoding in selected river and reservoir populations in North Rift region, Kenya. The fish was sampled from randomly selected sites covering man-made reservoirs and rivers that provides services to communities living around them. Sampling of fish was carried out using sein net and Electrofisher. The captured fish were identified in the field using morphological characteristics, weighed (grams), measured (Standard length, cm), photographed and preserved in 10% formalin for laboratory analysis. The fins were clipped and preserved in 90% ethanol for genetic analysis. Eighteen morphometric measurements and eleven meristic counts were recorded. PCA results on morphomeristic characteristics separated the four species of fish and showed similarity in morphometric characteristics of *Enteromius apleurogramma* and *Enteromius cercops* overlapping, whereas *Enteromius neumayeri,* and *Enteromius paludinosus* populations of fish, Meristic counts did not separate the populations of the four species. The Cytochrome oxidase (COI) sequences from the barcoding marker clearly indicated the presence of four *Enteromius* species in the sampled water bodies of North Rift, Kenya. The reference sequence identified *E. neumayeri, E. apleurogramma, E. paludinosus* and *E. cercops* with an accuracy percent identity ranging from 97.26% to 100%. The morphometric and meristic was not clearly separating the *Enteromius* populations from the different rivers and reservoirs suggesting the potential of COI barcoding as a robust tool for species delineation in aquatic ecosystems. Furthermore, this information will aid in making informed decisions regarding the management and conservation of these unique fish species in the North Rift, Kenya.

STRENGTHENING THE FISH VALUE CHAIN FOR FOOD SECURITY AND ECONOMIC EMPOWERMENT

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Rio fish is a social enterprise, committed to creating economic and social impact in Lake Victoria region. It is founded under the principles of environmental stewardship and social responsibility; it leverages innovative technologies to revolutionize the aquaculture value chain, effectively addressing the critical gap between fish demand and supply.

By investing in sustainable and efficient practices, Rio Fish enhances fish production while safeguarding the long-term health of aquatic ecosystems. The company champions sustainable cage fish farming, which not only meets the immediate need for fish but also plays a vital role in conserving the region's natural resources. This dual focus on productivity and sustainability positions Rio Fish as a leader in responsible aquaculture.

A key aspect of Rio Fish's mission is the empowerment of women within the local community. Currently, Rio Fish support 600 women in cooperatives in various stages of tilapia farming ranging from cage farming and processing to aggregation and marketing hence the enterprise promotes gender equality and economic growth. Investments in cold storage facilities further bolster the women's role in the value chain, enhancing consumer trust and market competitiveness.

Through this inclusive approach, Rio Fish not only provides a stable and affordable source of nutrition but also contributes to the broader economic development of the region. By engaging women in critical areas of the fish supply chain, Rio Fish fosters a more equitable and resilient food system, positively impacting the community at large.

Additionally, Rio Fish is committed to promoting a circular-green economy by utilizing fish waste to generate biogas, thus contributing to a cleaner environment. This innovative practice underscores the company's dedication to sustainability and resource efficiency, further distinguishing it in the marketplace.

The business's commitment to quality and sustainability sets it apart in the market, making it a key player in the industry. It is a catalyst for change in the aquaculture industry, making significant strides toward a more sustainable future for Lake Victoria and its communities.

THE POLICY RESEARCH NETWORK FOR FISHERIES AND AQUACULTURE IN AFRICA

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The Summit of African Heads of State and Government in Malabo, Equatorial Guinea, June 2014, endorsed the Policy Framework and Reform Strategy for Fisheries and Aquaculture in Africa (PFRS) as a blueprint to facilitate transformation of Africa's fisheries and aquaculture for food, livelihoods, and wealth. The PFRS identifies the inadequate capacities of some African Union Member States for the analysis of fisheries and aquaculture information and data to develop scientifically informed decisions for the sector. In this regard, AU-IBAR in 2015 commissioned an assessment study, that recommended the establishment of the Policy Research Network for fisheries and Aquaculture in Africa (PRNFAA) (Satia 2015). The Satia Report reiterated that "evidence-based, timely, and relevant information generated through the conduct of more cohesive and better-focused, high-quality research will greatly enhance the realization of the policy reform objectives of the PFRS as well as address emerging problems and challenges".

Under the funding of EU supported first Fisheries Governance Project, the Policy Research Network for Fisheries and Aquaculture in Africa (PRNFAA) was formally established on 20th April 2018, during the inaugural meeting, that was convened by AU-IBAR and NPCA (now AUDA-NEPAD) in Nairobi, Kenya. The PRNFAA was formally endorsed as a statuary organization of the African Union by the Third Ordinary Session of the Specialized Technical Committee (STC) on Agriculture, Rural Development, Water and Environment in 2019. It is consequently among the Non-State Actor networks of the Africa Fisheries Reform Mechanism. In 2024, PRNFAA was legally incorporated under Malawi law (under The Common Law).

The overarching objective of the PRNFAA (the Network) is to contribute to the effective implementation of the policy reform objectives of the Policy Framework and Reform Strategy for Fisheries and Aquaculture in Africa (PFRS) through the conduct of a more cohesive and better focused evidence-based, high-quality research agenda. The Network currently constitutes 133 members, drawn form 27 African and 6 non-African countries.

The objective of the PRNFAA's side event and dedicated plenary sessions are set and review Africa's progress towards bridging the PFRS's science-policy gap as envisaged in the Satia 2015 Report, reassess the science priorities, and set a strategic science agenda that ensures sustainable development of the aquatic food systems and blue economy sectors across Africa.

WHEN NO NEWS IS GOOD NEWS: HOW ACTIVE SURVEILLANCE CONFIRMS DISEASE FREEDOM IN SOUTH AFRICAN ABALONE

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South Africa's farmed abalone (*Haliotis midae*) sector plays a critical role in the national aquaculture economy and relies heavily on continued access to high-value international markets. To support international trade and provide scientifically credible assurance of disease freedom, the Department of Forestry, Fisheries and the Environment (DFFE) coordinates a national surveillance programme for aquatic animal diseases. The programme targets both World Organisation for Animal Health (WOAH)-listed diseases and other endemic diseases of national significance. Although *Haliotis midae* has not been identified by WOAH as susceptible to any listed diseases, other *Haliotis* species have been assessed as susceptible to infections with Abalone herpesvirus, *Perkinsus olseni*, and *Xenohaliotis californiensis*.

The surveillance programme includes components of passive surveillance, targeted surveillance, and a risk-based, active non-targeted surveillance component or stock inspections. These elements are integrated to enhance early detection, provide evidence for disease freedom, and inform national risk management strategies. Together, they support the sustainable health management of *Haliotis* spp. and underpin continued market access for South African abalone products.

The stock inspections are not triggered by clinical suspicion, but instead proactively monitor apparently health populations to detect disease should it be present. This component is risk based, with surveillance frequency being informed by a disease risk model that estimates the likelihood that a farm would express detectable clinical signs if a pathogen were present. At each farm, a statistically sufficient number of abalone baskets are inspected to achieve a 95% confidence of detecting disease at a 2% design prevalence. Inspectors inspect the selected baskets for mortalities and clinical signs such as tissue necrosis, shell abnormalities and behavioural changes. Suspect samples are sampled and tested using sufficiently validated diagnostic methods.

This presentation outlines the development and ongoing refinement of the risk estimation model, drawing on field inspection data from 2017 to 2023. The integration of longitudinal surveillance data over time has enabled improved risk stratification, better resource allocation, and enhanced confidence in surveillance outcomes. Findings contribute to the demonstration and maintenance of national disease freedom status and support the issuance of export health certificates. Ultimately, this work demonstrates how the absence of disease, when backed by a robust, risk-informed system, can serve as powerful evidence for maintaining access to internation markets.

AQUACULTURE EDUCATION EXTENSION STRATEGIES

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Aquaculture is among the fastest growing segments of agriculture worldwide, yet it is still surrounded by misconceptions, myths and lack of understanding. Our job as Extension educators is to find ways to build aquaculture literacy, aid existing and potential practitioners and help train the next generation of aquaculture scientists. Using a multimodal, three-pronged approach allows us to reach teachers and students, producers and researchers, and the public, locally and around the world.

Prong 1 - Using a train the trainer approach with teachers has a multiplying effect. Each teacher has the potential to educate more than 200 students per year. Through our Aquaculture and Aquaponics 101 workshops we have trained more than 700 teachers using hands-on experiences and group learning activities. In addition, Auburn University offers summer camp experiences for 15–18-year-old students. These camps include five days of intense fun and firsthand activities blended into a creative learning experience that provides the broadest possible exposure to natural resource careers with an emphasis on aquaculture, fisheries, and aquatic ecology.

Prong 2 – Webinars provide professional development opportunities for farmers, researchers, students and educators. Thus far, in 2024, the United States Aquaculture Society webinar committee in partnership with WAS, the National Aquaculture Association (NAA) and the Alabama Cooperative Extension System have offered 4 learning opportunities for more than 2,000 people from 62 countries.

Prong 3 – The US Aquaculture Society and the Aquaculture Education and More YouTube channels provide on-demand education for a worldwide audience. These channels have garnered more than 1.25 million views and provided over 65,000 hours of education for people around the globe.

It is our hope that this three-pronged approach can be duplicated by many other entities to help raise aquaculture awareness.

IMPROVING TRADE UNDER THE ONE STOP BORDER POST (OSBP) IN THE SADC REGION, STRATEGIC AND OPERATIONAL GUIDE TO ASSESS THE CONFORMITY OF FISHERY AND AQUACULTURE PRODUCTS

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The *Programme for Improving Fisheries Governance and Blue Trade Corridors in the SADC Region* (PROFISHBLUE), funded by African Development Fund (ADF) is coming to an end. With the objective to promote the sustainable management of fisheries resources within the Blue Economy context to improve food and nutritional security, create employment through value chain activities, facilitate intra-regional trade, and build adaptive capacity against climate change and other external shocks, agreements between the SADC secretariat, UNIDO and other implementation partners have successfully contributed to 'Policy harmonization and trade facilitation towards intra-regional trade'.

Under this project, UNIDO developed a strategic and operational guide that serves as a crucial tool to help mitigate challenges such as delays, increased costs, and regulatory discrepancies that currently hinder trade in fish and fishery products at borders. The main aim of this document is to contribute to enhance the formal fisheries trade through outlining a strategic approach to conformity assessment of fishery products and core requirements for overcoming barriers and avoiding disruption to fisheries trade between Member States with operational OSBPs.

Recently validated at the SADC Technical Fisheries Committee, this guide is foreseen to be a vital tool towards a comprehensive framework for enhancing trade efficiency, ensuring compliance with regulations and standards, and promoting sustainable and inclusive economic growth competitive market of blue foods, benefiting both current and future generations for the region.

FROM CRISIS TO CONTROL: HOW DATA-DRIVEN FISH HEALTH MANAGEMENT IS TRANSFORMING NIGERIA'S AQUACULTURE INDUSTRY

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The Lagos fish farming industry is dominated by non-professionals and an aging population, with 48.1% of farmers above 53 years and many farms operated by proxy by retirees and civil servants. This has resulted in a lack of technical expertise and a high failure rate among farms. Disease outbreaks are frequent, yet 47.2% of farmers rely on visual inspection and 45.3% on experience, diagnosing through trial and error rather than proper laboratory tests. As a result, farmers often misdiagnose health issues and 46.2% resort to self-prescribed antibiotics or recommendations from drug stores and co-farmers. Meanwhile, 61.3% have never received training on responsible antibiotic use, worsening antimicrobial resistance (AMR) concerns.

Despite the 82.1% demand for disease diagnosis services and 72.6% request for water quality assessments, Lagos farmers continue to struggle with technical inefficiencies. Disease mismanagement has led to 47.2% of farms experiencing outbreaks in the last month alone, forcing many farms to shut down. New entrants, mostly inexperienced and lacking technical skills, repeatedly fail, creating a vicious cycle of farm closures and fresh novice participation, making the industry increasingly unstable.

To address this, Rid Labs' Fish Health and Management Support Program (FSP) is training young aquaculture graduates as Fish Health Managers, equipping them with modern diagnostic and management skills. This initiative will improve farm productivity, reduce antibiotic misuse, and promote sustainable practices, making fish farming a more attractive and profitable career.

With Lagos as a model, FSP will expand to Ogun, Oyo, Osun Kwara, Delta, Rivers states and Abuja, transforming fish farming into a technically sound, sustainable, and economically viable industry nationwide.

INTERVENTIONS TO REDUCE DISEASE AND ANTIMICROBIAL USE IN AQUACULTURE

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Infectious diseases remain a major constraint to sustainable aquaculture, resulting in significant production losses and economic impacts, including freshwater fish farming systems such as tilapia. These challenges are frequently addressed through the administration of antimicrobials, which contributes to the global threat of antimicrobial resistance (AMR). Strengthening preventive strategies—including enhanced biosecurity and vaccination—is essential to reduce disease incidence and antimicrobial reliance, while supporting the sustainable intensification of aquaculture.

The International Centre for Antimicrobial Resistance Solutions (ICARS; www.icars-global.org) will be introduced, highlighting how low- and middle-income countries can access technical and financial support to pilot and evaluate interventions aimed at reducing disease and antimicrobial use in aquaculture. At the conference, examples of applied research projects supported by ICARS in Vietnam and Chile will be presented. In Vietnam, data will be shared from an intervention evaluating the effects of vaccination in catfish farming against *Aeromonas hydrophila* and *Edwardsiella ictaluri* on disease incidence, mortality, feed conversion ratio, and antimicrobial use. In Chile, a collaborative effort with the salmon industry, regulators, and researchers is underway to develop a catalogue of cost-effective, scalable interventions to enhance disease prevention and reduce antimicrobial use.

Additionally, a draft *Biosecurity Guideline for Cage Fish Farming in Tanzania: Risk Mitigation, Aquatic Animal Health, and Ecosystem Sustainability* will be presented. Developed with financial and technical support from the project *Antimicrobial Resistance and One Health, including Animal Health, the Environment, and Practitioner Engagement (AMROH), Eastern and Southern Africa (ESA)*, funded by the Fleming Fund, UK - the guideline promotes preventive practices, early disease detection, rapid outbreak response, and evidence-based biosecurity planning. It targets both cage fish farmers and government inspectors, aiming to support the development of practical, auditable biosecurity plans. The guidelines are also highly relevant for tilapia cage farming in Uganda and Kenya, given the shared access to Lake Victoria and its increasing use for intensified aquaculture.

These initiatives illustrate a global shift toward integrated, preventive approaches that support aquatic animal health, environmental sustainability, and responsible antimicrobial use.

ANTIBIOTICS USE AND ITS GOVERNANCE IN AQUACULTURE: KNOWLEDGE, ATTITUDE, PRACTICES, AND CHALLENGES AMONG FARMERS AND STAKEHOLDERS ON THE VOLTA LAKE OF GHANA

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Background: The use and misuse of antibiotics for treating animal and human infections are a key driver of the emergence of resistant bacterial strains at the human-animal-environment interface. This inappropriate use threatens ecological balance and poses a significant risk to human health. The lack of relevant knowledge of the right attitudes and practices regarding antimicrobial stewardship among fish farmers, antibiotic drug retailers, and government agencies has significantly exacerbated this serious environmental and public health issue. This study aimed to assess the knowledge, attitude, and practices of key stakeholders regarding the use of antibiotics in cage aquaculture on Volta Lake in Ghana.

Method: We conducted a qualitative and quantitative field survey involving interviews, key informant discussions, and observations. The participants were fish farmers across three scale: small, medium, and large, veterinary drug retailers and government officials from the fisheries, aquaculture, and veterinary sectors to gather insights about their knowledge, attitudes, and practices on antibiotics use in aquaculture. The study covered 91 fish farmers, and 40 stakeholders, comprising 18 veterinary drug retailers, 12 general pharmaceutical shop operators, five Fisheries Commission officials, and five government-trained veterinary personnel operating along the stratum II of the Volta Lake of Ghana. All quantitative and qualitative data were analysed using STATA and thematic analysis.

Results: From the survey, all sampled populations admitted to antibiotic applications in their fish farming operation. Knowledge of antibiotic types was mainly influenced by peers (46.15%), with tetracycline being the most recognized and used. There was a significant reliance on the empirical use of antibiotics, with 52.75% of farmers using them based on personal experience and 40.66% without a prescription. When initial treatments failed, 41.76% of the farmers would change or combine drugs. Older farmers (over 51 years) and those with tertiary education demonstrated significantly better KAP scores regarding antibiotic use. Strong correlations were also found among knowledge, attitudes, and practices in antibiotic usage. The qualitative survey revealed that drug retailers possess limited knowledge, expertise, and education on the use of antibiotics in fish farming. The results further revealed a lack of regulation in selling veterinary drugs to farmers. Despite this, the results indicate insufficient coordination between government officials, drug retailers, and fish farmers regarding the usage of antibiotics in aquaculture on Lake Volta.

Conclusions: Regular joint training programs are encouraged to improve and enhance knowledge, attitudes, and practices among government officials, veterinary drug retailers, and fish farmers. Under the One Health framework, efforts to integrate veterinary drug retailers, fish farmers, and other stakeholders of concern in antibiotic governance are required to address the increasing burden of antibiotic misuse and abuse in aquaculture in Ghana and the world.

GROWTH PERFORMANCE, NUTRIENT UTILIZATION AND WELLBEING OF AFRICAN CATFISH (*Clarias gariepinus,* Burchell, 1822) FINGERLINGS FED DIET CONTAINING *PROCESSED* WILD GRAPES (*Ampelocissus africana*)

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The high cost of fish feed has necessitated continuous efforts to seek alternative ingredients that could substitute or replace the major fish feed ingredients in high demand by man. This study evaluated the potential of raw and fermented wild grape (*Ampelocissus africana*) as a replacement for maize in fish diets. *Ampelocissus africana* leaves were collected in Dutsin-ma town, dried, ground and fermented with and without commercial dry yeast (*Saccharomyces cerevisiae*) with a cell density of 3 x 10^6 cell g^{-1} where sub-samples were taken for proximate, phytochemical and amino acid analysis. Five diets (T1-T5) were formulated as control (T1) 24 hours Grapes fermented with yeast (24GFY as T2), 48 hours grapes fermented with yeast (48GFY as T3), 48 hours Grapes fermented with no yeast ((48GFNY as T4) and Raw grapes (GRW as T5). Three Hundred (300) fingerlings of *Clarias gariepinus* with an initial mean weight of 15±2.31g were obtained and fed the experimental diets twice daily at 5 % body weight for eight weeks in a complete randomized design (CRD). Fish sampling was carried out weekly for the eight weeks and the weight was used to compute performance indices. The differences among the means for each of the indices were analyzed using one-way Analysis of Variance (ANOVA) at p = 0.05 and further analyzed using Duncan's multiple range test (DMRT) to determine the specific means that were different. The liver was taken for histopathological examinations using standard methods.. The highest percentage weight gain 65.13±10.79% was observed in the control and it was different significantly ($P<0.05$) from 24GFY and GRW but not significantly different from 48GFY and 48GFNY. The food conversion ratio followed the same pattern with the least in the control followed by 48GFY and 48GFNY and they were all different from 24 GFY and GRW. The hepatosomatic index and viscerosomatic index were not different significantly among the treatments. Histological examination of the liver also showed the least energy deposit in the 24 GFY and GRW. The results revealed that although the control with maize had superior performance, among the different inclusions of processed wild grape, fish fed diet with 48 hours fermented wild grape performed best. It is therefore recommended that different inclusion levels of wild grape fermented for 48 hours should be experimented in order to optimize its inclusion in fish diets.

VARIATION IN GROWTH TRAITS AMONG FULL-SIB FAMILIES FROM GENETICALLY DISTINCT NILE TILAPIA (*Oreochromis niloticus*) POPULATIONS IN UGANDA

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Nile tilapia is vital for food security and income generation in Uganda, serving as the primary fish species in aquaculture. However, production has stagnated in recent years, largely due to limited access to high-quality fish seed, leading to poor yields, despite increasing market demand. This challenge is further compounded by rising global temperature, which negatively impacts growth in both wild and farmed populations. This study investigates genetic variation in growth-related traits among Nile tilapia populations in Uganda, with the goal of enhancing growth performance and improving overall aquaculture productivity.

A total of 78 full-sib families of Nile tilapia were generated using a single-pair mating design in hapas (1 m × 2 m × 1 m), comprising 26 families from Lake Albert, 29 from Lake Victoria, and 23 from Lake Edward. All families were reared communally under uniform conditions for 143 ± 16 days to evaluate growth performance. At the end of the period, body weight, standard length, and total length were measured to assess phenotypic variance components and estimate heritability. A mixed linear model was applied, incorporating initial weight, batch, age, and stocking density as covariates, with restricted maximum likelihood (RML) used to estimate variance components.

All growth traits showed significant differences among the local Nile tilapia populations ($p<0.05$). Heritability estimates varied from low to high across populations (Table 1), indicating genetic variation in growth potential. Although the coefficients of variation for growth traits were not statistically significant ($P>0.05$), they ranged as follows: 35.5% to 36.3% for body weight, 11.8% to 12.3% for total length, 11.7% to 12.3% for standard length, and 35.6% to 36.2% for daily body weight gain.

The observed genetic variation and significant differences in growth traits among Nile tilapia populations highlight the potential for selective breeding to enhance growth performance and productivity in Uganda's aquaculture sector.

Table 1. Means ±Standard error and estimates of heritability (h^2) after a 143 ± 16-day culture period.

Population	Body weight (g)		Standard length (cm)		Total length(cm)		Daily body weight gain (g)	
	Mean±SE	h^2	Mean±SE	h^2	Mean±SE	h^2	Mean±SE	h^2
L. Albert	$32.1±1.7^{b}$	0.19	$9.1±0.2^{b}$	0.15	$11.4±0.2^{b}$	0.19	$0.225±0.01^{b}$	0.19
L. Victoria	$27.1±1.7^{ab}$	0.31	$8.7 ±0.2^{ab}$	0.92	$10.9±4.8^{ab}$	0.92	$0.187±0.05^{ab}$	0.34
L. Edward	$21.8±1.9^{a}$	0.61	$8.26±0.2^{a}$	0.50	$10.3±0.2^{a}$	0.51	$0.150±0.01^{a}$	0.57

Columns sharing the same letter superscripts are not significantly different at P = 0.05.

MAR: THE AMPHIBIOUS ROVER FOR THE PROTECTION OF LAKE VICTORIA – MONITORING, RESTORATION, AND INVASIVE SPECIES CONTROL

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Lake Victoria, the largest freshwater body in Africa, is currently threatened by several factors, including pollution, the proliferation of invasive plants, overexploitation of fish resources, and climate change. These issues endanger the lake's biodiversity and the livelihoods of millions of people who depend on its waters.

In this context, the use of the Multipurpose Amphibious Rover (MAR), an autonomous amphibious vehicle, could provide innovative solutions to address some of the lake's environmental challenges.

Monitoring and Early Warning for Pollutants:
The MAR is an amphibious vehicle designed for rapid deployment in early warning operations, focused on chemical and physical water analysis. Equipped with advanced sensors, it detects real-time changes in water characteristics and generates alerts for abnormal conditions. This allows authorities to quickly address pollution threats like fertilizers, pesticides, and mercury. Additionally, the MAR can release biotechnological powders, such as enzymes or bacteria, to aid in environmental restoration.

Water Quality Monitoring:
The MAR can monitor key water quality parameters like dissolved oxygen, pH, temperature, and nutrients using advanced sensors. This helps detect early signs of deoxygenation caused by invasive species like Water Hyacinth, which disrupts oxygen distribution and harm aquatic life.

AI-Based Aquatic Ecosystem Monitoring:
The MAR uses Artificial Intelligence (AI) with advanced sensors and high-resolution cameras to identify and geolocate invasive species like Water Hyacinth and Nile Perch, aiding ecosystem management and monitoring.

Support for Containing Invasive Species:
The MAR can use robotic arms with underwater arms to cut Water Hyacinth roots without harming native plants. AI helps identify which roots to cut, controlling the plant's growth.

The Multipurpose Amphibious Rover (MAR) is an innovative solution for monitoring and controlling invasive species in Lake Victoria and other African lakes. Equipped with advanced sensors, underwater actuators, and AI, it can detect and selectively remove Water Hyacinth, limiting its spread. The MAR operates autonomously both on the surface and underwater, enabling efficient interventions in hard-to-reach areas. Its integration with environmental data collection systems ensures continuous monitoring of water quality and containment efforts.

The MAR plays a key role in protecting biodiversity and supporting local communities.

FINANCES DEMONSTRATE “BEST” MANAGEMENT METHODS.

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Gross Profit (GP) Margin enables farmers to compare the profitability of their farm over different periods even when revenues differ. This session will include extended discussion with farmers on components of Cost of Sales (COS) in an aqua-business and analysis of GP margin. The session will focus on building an understanding of the cost of production for each production cycle and will cover standardizing inputs across production systems (i.e. feed, fingerling, medication, utilities, labor, marketing). Participants will be briefly introduced to the required financial and accounting terminology, before engaging in further open discussions. Attendees will understand that the effectiveness of every husbandry practice shows up in the financial figures. It will stimulate farmers to on all tiers to keep relevant farm records with an intent to use them for decision making.

DERISKING AQUACULTURE, THE ROLE OF THE FARMER

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Financial institutions mostly consider aquaculture a “Blackbox”. They face a range of risks when engaging with the aquaculture sector which can impact the profitability and viability of aquaculture ventures, ultimately affecting the financial institution’s investment and loan portfolios. Understanding and carefully managing these diverse risks is crucial for fostering a sustainable and financially sound aquaculture sector that benefits both producers and financial institutions. This session will aim to bridge the gap between farmers’ and investors’ perceptions on risk of a fish farm venture. After the session, farmers should be able to see similar risks as an investor and feel less frustrated by the investor’s validation hurdle.

UNLOCKING THE POTENTIAL OF AZOLLA: A CLIMATE-RESILIENT AND SUSTAINABLE SOLUTION FOR ENHANCING FISH FEED PRODUCTION AND AQUAPONICS INTEGRATION IN UGANDA

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Uganda's growing population and rising demand for animal protein coupled with increasing reduction of wild fish catches highlight the need for sustainable aquaculture solutions (Maulu et al., 2024). However, the aquaculture sector is challenged with availability of affordable feed, and aquatic environmental issues. This study intends to explore the potential of Azolla, a high-protein aquatic fern, as a sustainable alternative feed for Nile tilapia and extend to other animals. The study will optimize Azolla cultivation for biomass yield, evaluate its nutritional value as a direct feed and feed ingredient, and assess its impact on fish growth, health, and feed efficiency. Additionally, it will build capacity on production of Azolla and Azolla based for the scientific community and farmers. Aligned with Uganda's National Development Plan IV and the SDGs (1, 2, and 13), this research aims to enhance aquaculture productivity, improve food security, and reduce environmental impacts, fostering sustainable and resilient fish farming practices.

STRENGTHENING HUMAN CAPACITY FOR SUSTAINABLE AQUACULTURE DEVELOPMENT IN UGANDA: STRATEGIES AND LESSONS FOR SUB-SAHARAN AFRICA

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Uganda's aquaculture sub-sector holds immense potential for enhancing food and nutrition security, generating income, and creating employment. With the national targets of producing one million tons of fish anually from aquaculture by the year 2030, the sector is strategically positioned to address pressing development needs. However, growth remains constrained by limited technical capacity, inadequate skills, and weak value chain linkages. Unlocking this potential requires a multi-faceted human capacity development strategy that equips stakeholders with technical, business, and environmental management skills. Key to this is implementing inclusive, hands-on, short-term training programs tailored for all the aquaculture value chain actors. These programs should go beyond basic farming techniques to cover the entire value chain, including fish health, post-harvest handling, value addition, market access, and business planning. Inclusion of women, youth, and persons with disabilities is essential for equitable sectoral growth.

Strengthening partnerships between academia, research, industries, and the government is vital for producing fit-for-purpose graduates. This includes joint curriculum reviews, experiential learning through internships and collaborative research that address practical industry challenges. Such linkages foster innovation and align academic outputs with market needs. Promoting best management practices (BMPs) is essential for sustainable and climate-resilient aquaculture. Hence, initiatives like Promoting Environmentally Sustainable Commercial Aquaculture (PESCA), project in Uganda, provide critical models for balancing productivity with sustainability. This ensures that aquaculture growth maintains ecological integrity, promotes long-term viability and climate resilience. Digital platforms offer scalable solutions for training delivery, enabling wide dissemination of materials such as Uganda's aquaculture training compendium.

Finally, establishing structured follow-up mechanisms after training ensures knowledge and skills are applied and results in measurable improvements. In conclusion, Uganda's experience with collaborative capacity building Ademonstrates that a strategic, inclusive, and integrated approach to human capacity development is key to transforming aquaculture into a commercially viable and sustainable sector. These insights offer valuable guidance for similar efforts across Sub-Saharan Africa.

LOW TROPHIC-LEVEL ORGANISMS, BIOFLOC AND MICROALGAE AS AQUAFEED INGREDIENTS IN INTEGRATED MULTI-TROPHIC AQUACULTURE SYSTEMS TO ENHANCE PRODUCTION OF ECONOMICALLY IMPORTANT SPECIES

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Sustainable aquaculture should be environmentally benign, profitable, ecologically efficient, product diversified and societally beneficial. Integrated Multi-Trophic Aquaculture, an old concept with new knowledge, appears to be an eco-innovative solution to achieve these objectives. The design of feeds for fish and shrimp is crucial in these systems because fish feed is the main input of nutrients for both animals and plants. The project aims to evaluate the effect of incorporating the low trophic-level organisms such as black soldier fly, biofloc and microalgae as ingredients in aquafeed on the nutrient utilization efficiency and the growth performance of the co-cultivated species. The experimental feed was tested at the laboratory scale in both aquaponics and marine integrated multi-trophic Aquaculture systems. The fish were cultured in a biofloc system and under different salinity levels (5,10, 15, 20, 25, 30 PSU). Fish diets, fish feeding rate and feeding schedules were designed to provide nutrients for both fish and plants. Dissolved oxygen, pH and temperature were monitored daily. Total ammonia nitrogen, nitrite and alcalinity, were monitored weekly. The results showed that the zootechnical performances of the co-cultivated species varied depending on the salinity levels used, the type of feed provided and the feeding time.

AL-KERAM INTEGRATED AGRI-AQUACULTURE SYSTEM "KIAAS"

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This is a sucess storie of aquaculture production in the Egyptian desert reproduced below demonstrate the potential for farming commercial species using limited water resources. it highlight different aspects of the role that aquaculture can play in saving food security and contributing to local economic development through the generation of additional opportunities and revenues, thereby reaffirming the crucial contribution of the sector to blue growth.

The Egyptian Aquaculture sector is characterized by ongoing innovation of production systems, especially climate smart aquaculture to reduce energy, chemical fertilizer and water inputs. This is achieved through systems incorporating solar energy, water reuse and agricultural crop integration which reduces the carbon footprint of the sector.

This closed-loop ecosystem is called integrated Agri-aquaculture systems, which are now the key feature in Egypt to address water scarcity, climate change, and rising energy prices, while ensuring the provision of healthy food to citizens.

This system is annovated in Egypt since 1997 by the private sector and called:
Al-Keram Integrated Agri-Aquaculture system "KIAAS".

ADVANCING TILAPIA WELFARE IN AFRICAN AQUACULTURE: LESSONS FROM EGYPT AND THE USE OF PRACTICAL DIGITAL TOOLS

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As aquaculture expands across Africa, ensuring the welfare of farmed Nile tilapia (*Oreochromis niloticus*) is critical not only for ethical reasons, but also for sustainable production, fish health, and market access. This presentation shares insights from the rollout of the Tilapia Welfare Assessment Protocol and App, developed by FAI Farms Ltd. and tested at scale in Egypt — the third-largest tilapia-producing country in the world and the first in Africa, leading the way in sectoral innovation and advancement.

The welfare protocol assesses tilapia across four key domains: environment, nutrition, health, and behaviour. It uses weighted indicators such as water quality (*e.g.*, pH, alkalinity), feeding practices and observed behaviours to calculate a General Welfare Index (GWI) and Partial Welfare Indices (PWIs). These indicators are grounded in peer-reviewed science but adapted for practical farm use.

The accompanying Tilapia Welfare App makes it easy for farmers and extension officers to collect data, receive instant welfare scores and identify areas for improvement. With over 2,000 farms registered and more than 5,000 assessments completed — with the majority in Egypt — the app is already supporting real-time decision-making, improving animal welfare and reducing preventable losses.

By combining rigorous science with user-friendly technology and capacity building, this work demonstrates how welfare can be integrated into day-to-day farm management. The lessons from Egypt are highly relevant to other African countries aiming to scale tilapia production while maintaining high standards of fish welfare and sustainability.

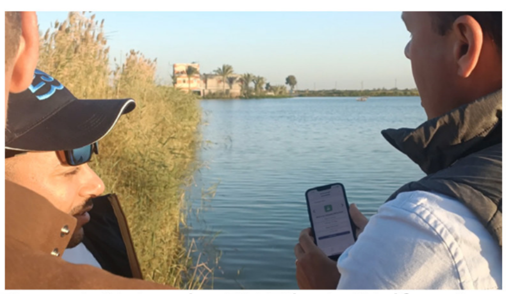

Figure 1. Using the FAI Tilapia Welfare App in Egypt

BACTERIOCIN-RICH EXTRACT FROM ENGINEERED LACTIC ACID BACTERIA AS AN ANTIBIOTIC ALTERNATIVE FOR THERAPEUTIC AND PROPHYLACTIC USE IN RUMINANTS AND AQUACULTURE (BAC4RUMA)

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Antimicrobial resistance (AMR) significantly threatens animal food production globally. Endangering human and animal health, AMR bacteria can be transmitted across the animal-human interface, between species and bidirectionally between humans, animals and the environment, contaminating the entire food system. Thus, regions with a reliance on mixed farming systems – as found in many low- and middle-income countries (LMICs) – are particularly vulnerable to AMR.

Nigeria is one such country where dairy and tilapia industries are at risk from the emergence and spread of AMR. Bacterial-induced mastitis, a mammary gland inflammatory disease affecting bovine milk production, is widely undermined in Nigeria's dairy industry. While several bacteria can cause mastitis, the methicillin-resistant bacteria *Staphylococcus aureus* ST88 (MRSA) is of particular concern. In other LMICs, MRSA has been identified in mastitis-affected cow's milk and can be transferred to humans, as found in, for instance, Nigeria and India. More recently, in India, it has also been found in aquatic environments and tilapia (*Oreochromis niloticus*) specifically. Considering that MRSA is attributed to antibiotic overuse, the risk of developing MRSA in Nigeria is significant due to high prophylactic and metaphylactic antibiotic use: more than 60% of Nigerian dairy farmers use antibiotics without a prescription. The development of MRSA would have significant consequences to Nigeria's dairy and burgeoning tilapia culture industry, as well as to human health.

Therefore, this study examines an antibiotic alternative for Nigerian dairy and tilapia farmers: bacteriocins. Bacteriocins are peptides produced by bacteria that exhibit broad-spectrum antibacterial activity (including to AMR bacteria), a reduced probability of resistance, with absent or limited toxicity to mammalian cells. While several herbal and essential-oil alternatives to antibiotics have been trialled, few have been approved for clinical use due to the complexity of their composition and the difficulty of accurately assessing efficacy and safety. Moreover, some bacteria are naturally resistant to herbal compounds, and others easily develop resistance over time. A combination of bacteriocins could be a realistic alternative to the use of antibiotics in LMICs because they are broad-spectrum, do not generate resistance, and can be produced as a bacteriocin-rich extract (BRE) easily and at a low cost.

This project aims to assess the potential of bacteriocins in preventing MRSA in Nigerian dairy and fish farms. Results will be presented from the project's five components: (1) a study of factors influencing treatment decisions using systematic surveys and focus groups, (2) engineering and production of BRE, (3) field trials in tilapia farms, (4) field trials in dairy ruminant farms, and (5) cost-benefit analysis. In this presentation, we introduce preliminary results from the systematic surveys and focus groups, discuss their implications for field trials, and consider their effect on project outcomes and habitual use of BRE instead of antibiotics.

TRANSCRIPTOMIC AND EPIGENETIC EFFECTS OF PHOTOPERIOD MANIPULATION ON THE PITUITARY GLAND OF ATLANTIC COD *Gadus morhua*

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Understanding the biological processes governing Atlantic cod (*Gadus morhua*) puberty is key to improving aquaculture efficiency and reducing environmental impacts in the Norwegian coastal zones and fjords. This study examined the impact of photoperiod manipulation on the growth and sexual maturation of Atlantic cod, by analysing morphometric characteristics as well as the transcriptomic and epigenetic profiles of the pituitary gland. Both male and female cod were subjected to either continuous light or ambient light conditions for a duration of 6 months, between 16 and 22 months of age. Our results revealed that size and sexual maturity are inextricably linked to transcriptomic (mRNA) and epigenetic (DNA methylation) profiles in the pituitary gland. Specifically, cod exposed to continuous light was significantly larger in size and sexually immature compared to their counterparts which had reached puberty.

To elucidate the molecular mechanisms underlying puberty and the observed growth differences, we performed RNAseq and EMseq on the pituitary gland of 9 male and 9 female cod exposed to continuous and ambient light, respectively (Fig 1). We identified a large network of genes and DNA methylation patterns that are likely involved in the regulation of puberty and somatic growth. Putative biomarkers have the potential to advance our understanding of how epigenetic mechanisms may regulate complex traits that are valuable to aquaculture and cannot be explained solely by genetics and heritability estimates. These findings are highly relevant to the aquaculture industry, where early sexual maturation is undesirable due to its links to negative effects, including lower fillet quality, increased post-spawning mortalities, and ecological concerns regarding gene flow into wild populations.

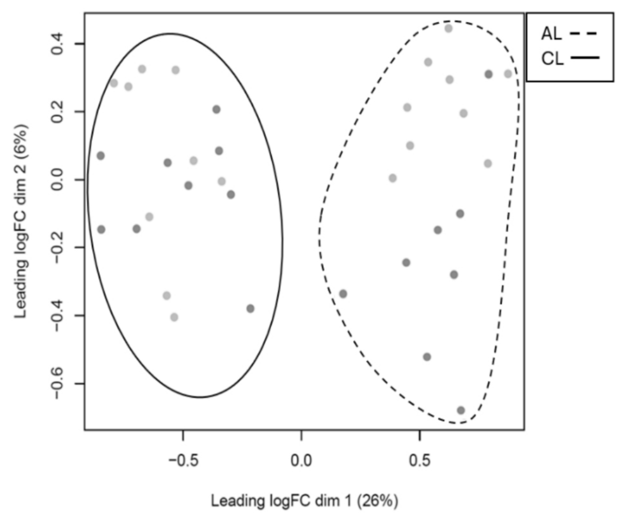

Figure 1. Principal component analysis based on transcriptomic data between cod exposed to ambient (AL) and continuous (CL) light. Darker and light grey dots depict males and females, respectively.

Acknowledgements
This study has received funding by the Research Council of Norway under the Researcher Project for Scientific Renewal (project No. 336112) with additional institutional support by the Spanish Ministry of Science and Innovation through grants HOLOSEX (PID2023-146286OB-I00, MCIN/AEI/10.13039/5011000110

33/FEDER) to JMOF, and 'Severo Ochoa Centre of Excellence' accreditation (CEX2019-000928-S) funded by AEI 10.13039/501100011033.

EFFECT OF PHOTOPERIOD MANIPULATION ON THE LIVER TRANSCRIPTOME IN ATLANTIC COD *Gadus morhua*

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In Atlantic cod aquaculture, precocious puberty is a major challenge, as it negatively impacts growth rate and fillet quality. The application of continuous light (CL) from the summer solstice prior to maturation has been shown to delay gonadal development to some extent and promote weight gain. The liver is most likely involved in these responses to photoperiod, since it is a key organ in overall metabolism. In this study, we aimed to investigate the effects of photoperiod on gene expression in Atlantic cod liver. Juvenile cod were divided into two groups and exposed to either ambient light (AL) or continuous light (CL) in triplicate tanks for 6 months. A total of 36 RNA-seq libraries (9 males and 9 females from each photoperiod condition) were prepared with the NEBNext Ultra II Directional kit. Using the Limma package, 2,542 significantly differentially expressed genes (DEGs, $|\text{Log2 fold change}| \geq 1$, Benjamini-Hochberg adjusted p-value ≤ 0.05) were identified. In females, 1,044 DEGs were found between CL and AL groups (704 up-regulated and 340 down-regulated), and in males there were 1,184 DEGs (800 up-regulated and 384 down-regulated). A total of 314 genes were differentially expressed between males and females under ambient light conditions (168 up-regulated and 146 down-regulated), whereas no DEGs were detected between males and females under continuous light conditions. Among the top DEGs, photoperiod manipulation affected the expression of *mogat2* (monoacylglycerol O-acyltransferase 2, LogFC 3.53) with down-regulation of *LOC115551355* (pellucid zone sperm-binding protein 3-like, LogFC -5.74), and *LOC115556237* (vitellogenin-2-like, LogFC -4.75). Gene Ontology (GO) terms enriched included “response to biotic stimulus” and “response to external biotic stimulus” in CL vs AL females. In males, enriched GO terms on “DNA replication” were associated with up-regulated genes, including *mcm5* (minichromosome maintenance complex component 5, LogFc 2.72), and *mcm2* (minichromosome maintenance complex component 2, LogFC 2.72) and “small molecule catabolic process” such as *tat* (tyrosine aminotransferase, LogFC -2.80) were observed comparing CL vs AL. In addition, a significant down-regulation of vitellogenesis-related genes (*LOC115556237*, LogFC -10.74) was observed in males compared to females under AL conditions, along with enrichment in “heme binding” and “tetrapyrrole binding” terms. These results provide novel insights into the regulation of gene networks responsible for growth and puberty in this commercially important fish species and this fundamental knowledge may contribute to more sustainable cod farming.

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This study has received funding by the Research Council of Norway under the Researcher Project for Scientific Renewal (project No. 336112) with additional support from the Spanish Ministry of Science and Innovation through FPI contract PRE2022-101795 associated to grant CEX2019-000928-S-20-5 funded by AEI 10.13039/501100011033, ‘Severo Ochoa Centre of Excellence’ accreditation (CEX2019-000928-S) funded by AEI 10.13039/501100011033 and the HOLOSEX grant (PID2023-146286OB-I00, MCIN/AEI/10.13039/501100011033/FEDER) to JMOF.

OPTIMIZING SOLAR POWERED POST HARVEST PROCESSES IN AQUACULTURE THROUGH THE IMPLEMENTATION OF SMART AND DATA DRIVEN CONTROL SYSTEMS

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This project explores the implementation of smart, data-driven control systems in solar-powered post-harvest processes in aquaculture, focusing on rural African contexts. Our work, part of the INNOECOFOOD project, emphasizes developing secure, proprietary infrastructure for data management and IoT connectivity, enabling the networking of multiple hubs across different locations to benefit from a shared, optimized system.

We developed smart algorithms leveraging real-time sensor data to optimize post-harvest operations, particularly drying processes of fish and other produce. This approach ensures consistent product quality, addresses energy scarcity, and enhances overall sustainability. The system prioritizes energy efficiency, optimizing processes like ice production, cooling, drying, and processing based on solar energy availability. By intelligently managing these energy-intensive operations, we significantly enhance the overall sustainability and economic viability of the post-harvest processes.

The system's design prioritizes user-friendliness, employing AI to analyze complex datasets and present actionable insights to local operators without requiring advanced data analysis skills. This democratization of technology significantly reduces reliance on individual expertise while maintaining high efficiency and product quality standards.

Recent studies show smart systems can significantly improve efficiency and product quality in aquaculture [1]. Our findings align with these results, indicating substantial enhancements in operational efficiency and consistency across the post-harvest chain [2]. Additionally, we explore the potential for integrating these systems with Recirculating Aquaculture Systems (RAS), further optimizing energy and water usage throughout the entire production process.

This work highlights the potential of smart control systems in revolutionizing aquaculture processes, particularly in resource-constrained environments. It underscores the importance of secure, locally-controlled data infrastructure and AI as tools to empower local operators, contributing to the sustainability and economic viability of aquaculture operations in Africa and beyond.[3, 4].

This project has received funding from the European Union's Horizon Innovation action under Grant Agreement no. 101136739 (INNOECOFOOD).

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THE NETWORK OF AFRICAN UNION CENTRES OF EXCELLENCE IN FISHERIES AND AQUACULTURE

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The Joint Conference of African Ministers for Agriculture, Rural Development, Fisheries and Aquaculture held in Addis Ababa, Ethiopia, in May 2014, recognized the challenges which affected the fisheries and aquaculture sectors in Africa. The minsters therefore, recommended that the African Union to establish an *'African Centre's of Excellence'* comprising Africa's tertiary and research institutions for aquaculture, capture fisheries, biodiversity studies and oceanography to generate the necessary information, knowledge and technology to build the continent's human resource and institutional capacities for the implementation of the Policy Framework and Reform Strategy for Fisheries and Aquaculture in Africa (PFRS). This recommendation was endorsed by the Executive Decision Doc. EX.CL/842(XXV) of the Summit of African Heads of States and Governments in June 2014, Malabo, Equatorial Guinea. In this regard, the following disciplines for which Centre's of Excellence should be established were identified, notably: aquaculture, capture fisheries, aquatic governance, policy and fisheries economics and vocational training & manpower development in fields related to fisheries & aquaculture. Bearing in mind the principles of the Africa Fisheries Reform Mechanism the research, an all-inclusive bottom-up participatory approach is expected of all actions undertaken by the AU-CoE's to ensure sustainability of outcomes and impact equitably across all regions of Africa and echelons of the sectors value-chain in compliance with the continent's overall objectives.

To-date a total of eight AU-CoE's have been engaged by AU in their areas of specialization. The side-event brings the AU-CoE's together to deliberate on strengthening innovation and technology development for the benefit of Africa's aquaculture sector, its stakeholders and the continent's citizens, as outlined by the African Union's *CAADP Strategy and Action Plan - 2026-2035: Building Resilient Agri-Food Systems in Africa*.

SMOKED CATFISH FILLETS (*Clarias gariepinus*) USING INNOVATIVE PROCESSES

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The world production of catfish (freshwater fish of the order Siluriform) reached in 2022 the second place among farmed freshwater fish (more than 6.6 million tonnes) just after carp. Catfish is considered a staple food in many Asian and African countries, and its popularity has been steadily growing in Europe and North America. Common catfish products include whole-dressed fish, standard and shank fillets, fillet strips, and nuggets.

Preservation and processing of catfish require experience in the evaluation of raw material quality, particularly in detecting off-flavours like geosmin and 2-methylisoborneol, which are secondary metabolites produced by certain bacteria and algae present in fishponds. Traditional methods like pickling, drying, and smoking can significantly enhance the quality, safety, and sensory attributes of the final products.

This study aims to optimize a smoked prototype using the African catfish *Clarias gariepinus,* and to assess the impact of different salting formulations with a curing/smoking process on quality, safety, and stability. Four formulations were tested (various levels of salt, sodium lactate, and sugar) and three independent trials were carried out to identify the optimal formulation for producing a nutritious, healthy, and stable product from a physical, microbiological, and sensory point of view.

The results revealed safety across all products with no detectable levels of Enterobacteriaceae or *Listeria* spp., and acceptable sensory properties with no significant differences among formulations. A second phase of the study is now underway, intending to assess the shelf life related to each formulation to determine the most suitable option. These results provide valuable insights for the freshwater fish aquaculture industry, promoting the development of high-quality smoked catfish products.

This work aligns with UNs priorities and demonstrates how innovation addresses real-world challenges in the agri-food sector, fostering competitiveness through improved seafood quality and safety.

Acknowledgment: This work was supported by project “INNOECOFOOD”, under the EU Horizon 2024 Research and Innovation program, grant agreement No.101136739.

BY-PRODUCTS AS FEED INGREDIENTS FOR PACIFIC WHITELEG SHRIMP *Penaeus vannamei*

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Feed ingredients are the most critical drivers of all environmental impacts in shrimp aquaculture. The use of conventional raw materials contributes to overexploitation of natural resources and may compete directly with human food supplies. Utilizing locally sourced by-products as feed ingredients offers a sustainable alternative by reducing waste, recycling nutrients, adding value, and promoting circularity of the aquaculture industry. In this work, so far underutilized by-products of several industries in northern Germany were identified, biochemically characterized, and tested. Multiple feeding experiments were conducted in clear water recirculating aquaculture systems with the Pacific Whiteleg shrimp *Penaeus vannamei.*

In a first step, by-products from shrimp fisheries, insect farming, cosmetics, food, and beverage industries were biochemically characterized and the digestibility of key nutrients was determined *in vivo* (Figure 1).

Based on these findings, shrimp remains (*Crangon crangon*) and adult black soldier flies (Imago, *Hermetia illucens*) were tested as a dietary protein source to replace fish meal (FM). Cocoons (*H. illucens*), algae pomace (*Saccharina latissima*), and carrot pomace (*Daucus carota*) were tested as functional ingredients to improve overall performance, health, and pigmentation of shrimp.

Shrimp remains improved growth and feed efficiencies at an optimal FM replacement of 85%. Adult black soldier flies suppressed growth of *P. vannamei* at all tested inclusion levels (13 – 26% of the feed). Cocoons and algae pomace significantly improved shrimp survival at a dietary inclusion of 5%. Dietary inclusion of 5% carrot pomace improved coloration of cooked shrimp but did not increase the total carotenoid and astaxanthin contents in hepatopancreas and uropods of shrimp. No adverse effects of any of the tested by-product were detected on hemolymph parameters (phenoloxidase activity, total hemocyte counts, plasma protein, plasma glucose) and digestive enzyme activities. Our results demonstrate that locally sourced by-products can be used as sources of protein, energy, and functional ingredient in shrimp feed formulations. The approach of utilizing side streams from traditional and emerging industries is transferable to many regions worldwide to enhance sustainability and profitability of aquaculture practices.

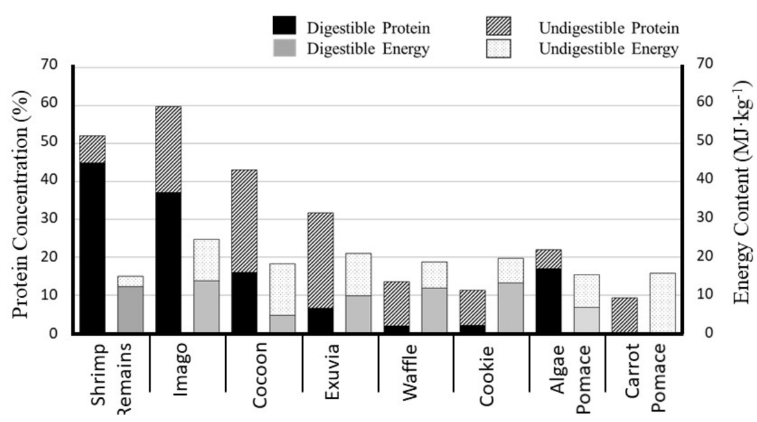

Figure 1. Digestible and undigestible protein and energy values of the investigated by-products used in this study.

BRIDGING SCIENCE AND SOCIETY: MY JOURNEY AS A COMMUNICATIONS EXPERT IN MARINE AND AQUACULTURE RESEARCH

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Effective communication of scientific research is essential for promoting understanding, fostering public trust, influencing policy, and driving innovation in aquaculture. As a communications expert at the Kenya Marine and Fisheries Research Institute (KMFRI), I have had the unique responsibility of translating complex scientific findings from multidisciplinary research departments into accessible, relatable content for diverse audiences — including local communities, policymakers, industry stakeholders, media, and the general public.

When I began this role, I had no prior background in the field of marine science or aquaculture, which posed significant challenges in grasping scientific jargon, navigating institutional structures, and establishing communication channels with researchers. However, these initial hurdles became powerful learning opportunities. I quickly immersed myself in the research environment, built strong collaborative relationships with scientists, and sought to understand the context and relevance of their work. Over time, I developed tailored communication strategies using digital platforms, traditional media, and participatory outreach to ensure that research outputs are not only disseminated but also understood and applied.

One of the key lessons I have learned is that science communication must go beyond translation — it must create meaning. By framing research outcomes in ways that resonate with specific audiences, I have helped amplify the visibility of KMFRI's contributions to sustainable aquaculture, marine spatial planning, climate change adaptation, and livelihoods improvement. Engaging visuals, storytelling, infographics, community engagement, and policy briefs have proven effective in transforming abstract data into actionable knowledge.

My journey underscores the critical role that communicators play in bridging the gap between science and society. It also highlights the importance of institutional support for capacity building, collaborative knowledge-sharing, and inclusive communication practices. As I continue this journey, I remain committed to learning, innovating, and supporting science-driven development in the aquaculture sector.

This presentation will share personal insights, practical strategies, and lessons learned from my experience — with the aim of inspiring other research institutions and professionals to invest in science communication as a core pillar of impact.

EVALUATING THE NUTRITIONAL VALUE OF BLACK SOLDIER FLY LARVAE MEALS PRODUCED ON SUBSTRATES CONTAINING VARIOUS SEAFOOD PROCESSING BYPRODUCTS WITH RED DRUM (*Sciaenops ocellatus*)

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There is a continuing need to develop and evaluate alternative protein and lipid feedstuffs as potential substitutes for traditional marine ingredients (fishmeal and fish oil) to support further expansion of aquaculture. In addition, there is increasing interest in utilizing nutritionally valuable raw materials from underutilized waste streams. Cultivation of black soldier fly larvae (BSFL) holds the potential to produce meals with high-quality nutrients to partially replace fishmeal and fish oil as well as satisfy modern sustainability demands. In the current study, BSFL meals were produced by growing BSFL on either a commercial (Gainesville) house fly substrate or one in which 75% of the commercial substrate was replaced with either processing byproducts (filleted carcasses) from red drum or tuna on an equal-weight basis. The BSFL raised on the various substrates were dried at 60C, processed into meals and then evaluated for nutrient digestibility with sub-adult red drum. Subsequently, a comparative feeding trial was conducted with juvenile red drum in which Special Select™ menhaden fishmeal (MFM) was replaced at rates of 0, 50, 75, and 100% on a digestible-protein basis. The reference (Ref) diet was composed of practical ingredients including MFM at 15% of dry weight to provide digestible protein at 36% of dry diet. The experimental diets included those in which BSFL reared on the Gainesville substrate replaced MFM at either 50% (G50) or 75% (G75), BSFL reared on red drum processing byproduct replaced MFM at 50% (RD50) or 75% (RD75), and BSFL reared on tuna processing byproduct replaced MFM at 50% (T50), 75% (T75), or 100% (T100).

Quadruplicate tanks of 17 juvenile red drum (~5.0 g initial weight) were cultured in 24, 38-L aquaria fashioned as a recirculating aquaculture system. Fish were fed to apparent satiation twice daily based on a percentage of body weight, which was adjusted weekly for the duration of the 6-week feeding trial. At the end of the trial, no statistical differences in weight gain were observed for any dietary treatment; however, higher dietary inclusions of BSFL reared on either seafood processing byproduct tended to decrease percentage weight gain (Figure 1) and feed efficiency. Similarly, body condition indices and muscle yield expressed as a percentage of body weight were not statistically different; however, a numerical increase in hepatosomatic index was observed in fish fed diets in which BSFL reared on seafood processing byproducts replaced 75 and 100% of dietary fishmeal. The current study suggests that 50% replacement of fishmeal using BSFL reared on unique seafood processing byproducts is feasible. Additional investigations are underway to further evaluate these BSFL meals.

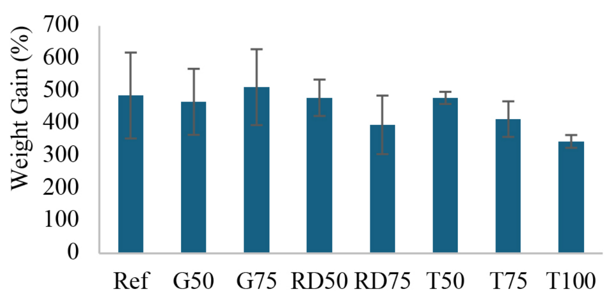

Figure 1. Effects of substituting fish meal with various BSFL products on weight gain (% of initial weight) of juvenile red drum over 6 weeks.

GENETIC CHARACTERIZATION AND INTERSPECIES GENE FLOW AMONG THE *Oreochromis* SPECIES IN THE LAKE VICTORIA AND KYOGA BASINS, UGANDA: IMPLICATIONS FOR CONSERVATION

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Despite the significant fishery contribution of the Victoria and Kyoga basins, the ecosystems have continuously been threatened by overfishing and the introduction of alien species, among others. These activities have contributed to a significant decline of the native tilapiines, the Singida tilapia (*Oreochromis esculentus*) and Victoria tilapia (*Oreochromis variabilis*). As a consequence, the native species have been relegated to smaller satellite lakes and replaced by non-native species comprising Nile tilapia (*O. niloticus*) and blue spotted tilapia (*O. leucostictus*). Therefore, to better understand the implications of these events, it is important to assess the status of both native and non-native species in the Victoria and Kyoga basins for sustainable science-based informed management options. Utilizing both microsatellite and mitochondrial (mt) DNA markers, we sequenced a total of 739 individuals from the Victoria and Kyoga basins comprising *O. niloticus* (333), *O. esculentus* (151), and *O. leucostictus* (258). Generally, all the species and their respective populations exhibited lower genetic diversity as well as genetic differentiation. The principal coordinate analysis showed three main distinct groups corresponding to the three species studied highlighting their genetic differentiation. However, some evidence of introgressive hybridization observed between *O. niloticus* and *O. esculentus* as well as *O. esculentus* and *O. leucostictus* suggests a need for a tailored management strategy to preserve the genetic integrity of all three *Oreochromis* species while minimizing the hybridization risks. The study recommends that the satellite waterbodies containing pure stocks of *O. esculentus* should be conserved separately with higher priority.

ENHANCING AFRICAN CATFISH (*Clarias gariepinus*) AQUACULTURE IN UGANDA: INSIGHTS INTO HATCHERY PROPAGATION, POPULATION SUITABILITY, AND BROODSTOCK MANAGEMENT

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The African catfish, *Clarias gariepinus*, is among the most important fish species for Uganda's rapidly growing aquaculture sector. The faster growth rates, higher survival rates, and resistance to environmental conditions have led to increased demand for improved African catfish broodstock and fish seed by farmers. Until recently, most studies of this species have focused on nutrition, physiology, and culture systems, with little known about the genetics, broodstock, and genetic management of different populations of wild and cultured *C. gariepinus*. Most hatcheries in Uganda typically obtain broodstock either from natural water bodies, without adhering to scientific selection guidelines, or from genetically degenerated stocks maintained in fish farms for extended periods without replacement. This practice has led to inbreeding depression, resulting in poor seed quality and reduced performance.

To establish a selective breeding program for optimizing catfish production, a survey was conducted across multiple catfish hatcheries and farms in Uganda. Using semi-structured questionnaires, the study assessed hatchery propagation methods, the suitability of various populations, and broodstock management practices, challenges, and prospects. Responses were coded and analyzed using Microsoft Excel (2021), applying both descriptive and inferential statistics. Key findings revealed that 70% of hatcheries sourced broodstock from fellow farmers, while 30% still relied on wild-caught broodstock, particularly from Lake Victoria. The average broodstock holding capacity ranged from 50 to 250 individuals per annum, with fewer than 25 families per hatchery, and less than 50% contributing to broodstock replacement. This low effective population size (Ne) increases the risk of inbreeding depression. Additionally, 46% of farmers hatch and select their broodstock, with over 90% prioritizing shooters (fast-growing cannibalistic fish) under the assumption that they have superior breeding value for growth. All farmers induce spawning using synthetic hormones (Ovaprim and Ovatide), and at the same time, 98% still sacrifice males to collect sperm. The reported hatchability rate was 60%, with a 60% survival rate from larvae to fry. On average, fingerlings (~2.0 g) required two months to grow, being fed commercial micro-diets. The study identified poor-quality broodstock as the primary challenge, followed by poor water quality and inadequate feeds. While the African catfish aquaculture industry in Uganda is expanding rapidly, certain hatchery practices pose significant risks to its sustainability if not properly addressed.

EFFECTS OF DIFFERENT SALINITY LEVELS ON THE REPRODUCTIVE SUCCESS OF BRINE SHRIMP *Artemia franciscana*

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Artemia franciscana commonly referred to as brine shrimp, is widely utilized in aquaculture for its high nutritional value and adaptability to hypersaline environments. This study investigated how varying salinity levels (80, 100, 120, and 140 gL^{-1}) affect the reproductive success of *A. franciscana*, specifically the production of nauplii and cysts. Cultures were maintained under controlled laboratory conditions, and reproductive output was observed over seven days using 16 falcon tubes (four replicates per treatment). Results showed that lower salinity levels (80 and 100 gL^{-1}) favored higher nauplii production, indicating increased ovoviviparous reproduction. In contrast, higher salinities (120 and 140 gL^{-1}) resulted in increased cyst production, suggesting a stress-induced shift toward oviparity. The overall reproductive success, combining both cysts and nauplii, was highest at 100 gL^{-1}, implying an optimal salinity range for balanced reproductive output. These findings offer practical insights into optimizing *Artemia* culture for hatchery use, supporting sustainable aquaculture practices in salinity-variable environments.

COMPARATIVE EVALUATION OF HATCHERY PERFORMANCE AND FRY SURVIVAL RATES BETWEEN *Oreochromis macrochir* AND *Oreochromis tanganicae* EGGS: IMPLICATIONS FOR AQUACULTURE PRACTICES

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This study was conducted at the National Aquaculture Research and Development Centre of Zambia to compare the hatchery performance and fry survival rates of *Oreochromis macrochir* (Greenhead tilapia) and *Oreochromis tanganicae* (Tanganyika bream). A total of 500 eggs from each species were collected and subjected to identical hatchery conditions: a temperature of 28°C, pH of 7.5, and dissolved oxygen level of 6 mg/L. Hatchery performance was measured by hatching rates and time to hatch, while fry survival rates were monitored over a four-week period.

Results indicated that *Oreochromis macrochir* had a higher hatching rate of 85% compared to 78% for Oreochromis tanganicae, with average hatching times of 3 days and 4 days, respectively. Fry survival rates for *Oreochromis macrochir* were consistently higher, with an 80% survival rate at the end of the fourth week, compared to 75% for *Oreochromis tanganicae*. The study suggests that *Oreochromis macrochir* is more suited for aquaculture under the given conditions due to its superior hatchery performance and fry survival rates.

The findings provide valuable insights into optimizing aquaculture practices and suggest that *Oreochromis macrochir* may be a more viable species for aquaculture in Zambia. Future research should explore long-term growth and reproduction rates, as well as the genetic factors influencing these outcomes.

ESSENTIAL CONTRIBUTION OF AQUATIC FOODS TO AFRICA'S SUSTAINABLE & RESILIENT FOOD SYSTEMS – CAADP KAMPALA DECLARATION, ACTION PLAN AND STRATEGIES 2026-2035

Hellen Guebama[1], Nelly Isyagi[1], Mohamed Seisay[1], Rafik Nouaili[1], Delvis Fortes[1], Kwame Mfodwo[1], Patrick Karani[1], Obinna Anozie[1], Bernice Mclean[2]

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Aquatic Foods play a fundamental role in Africa's food systems, supplying 18% of all animal proteins, well above the 15% world average. The intrinsic link between fisheries and aquaculture and Africa's core continental development objectives was recognised by Member States as early as 2005 during the NEPAD "Fish for All Summit". The adoption of the 2014 Policy Framework and Reform Strategy for Fisheries and Aquaculture (PFRS), and its alignment with the CAADP Kampala Declaration, has provided a blueprint for sustainable reforms of the sector.

EFEITO DA RAÇÃO ARTESANAL À BASE DE RESÍDUOS VEGETAIS E VÍSCERAS DE PEIXES NO CRESCIMENTO DA MASSA CORPORAL DO JUVENIL DA TILÁPIA DO NILO *Oreochromis niloticus*

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Esta apresentação examina o impacto da ração artesanal no crescimento da massa corporal da tilápia do Nilo *Oreochromis niloticus*. O objetivo é avaliar a eficácia das formulações de ração artesanal comparadas às rações comerciais no desempenho do crescimento dos peixes. A pesquisa envolveu a formulação de diferentes tipos de ração caseira com ingredientes locais (mandioca, milho, couve) e vísceras de peixe, em sua aplicação em cultivos de tilápias em condições controladas. Para este efeito foram amostrados 55 peixes, distribuídos e povoados em 3 tanques com um volume de 250L para os tanques T1 e T2 respectivamente e 200L para o tanque T3. Sendo que os juvenis de *O. niloticus* com peso médio inicial de 2100g e 18,03cm de comprimento inicial alimentados uma ração artesanal (T_1); e 2250g e 17,58cm alimentados com uma ração comercial (T_2); e 2750g e 19,01cm alimentados com uma mistura de ração (T_3), durante 22 dias na fazenda do Missombo, província do Cuando Cubango – Angola.

No final do experimento o tratamento T1 atingiu peso médio de (2850g); o tratamento T2 atingiu (3150g) e o tratamento T3 atingiu (4100g). Para os peixes submetidos a dieta experimental (T1) o ganho em peso foi de 30 mg/dia. Para os peixes submetidos a dieta comercial (T2) foi de 36 mg/dia e para os peixes submetidos a dieta mista (T3) foi de 54 mg/dia.

O tratamento T1 teve uma biomassa total produzida de 0,015kg; para o tratamento T2 foi de 0,018 kg e para o tratamento T3 foi de 0,020 kg e um incremento em peso de: 0,75g, 0,9 e 1,35 para o tratamento T1, T2 e T3, respectivamente, com uma taxa de sobrevivência de 75,53% para todos os tratamentos.

Os três tratamentos apresentaram diferença no crescimento e ganho de peso, apesar do tratamento T3 apresentar melhores resultados relativamente ao tratamento T1 e T2.

Concluímos que a formulação adequada de ração artesanal pode optimizar o desempenho de crescimento da tilápia do nilo *O. niloticus*, oferecendo benefícios significativos para a aquicultura local substituindo de forma parcial à ração comercial, diminuindo assim os custos com relação a alimentação dos peixes uma vez que representa 70% dos custos de produção.

Tabela 1 - Resultados dos parâmetros do desempenho e do efeito da ração no crescimento da massa corporal do juvenil da Tilápia O. niloticus nos três tratamentos.

	Comprim medio m)	**Incremento e comprimento**	**Comprim medio fin (cm)**
T1: foi usada a ração artesanal	18,03 cm	1,59	19,62
T2: foi a mistur ração comercial ração artesanal	19,01	3,02	22,03
T3: foi usado a ração comercial	17,58	2,95	20,53

Tabela 2: Resultados da taxa de sobrevivência, factor de conversão alimentar e da biomassa produzida nos três tratamentos

	Biomassa (kg)	**Conversão alimentar (g)**	**Taxa sobrevivência (%)**
T1:	0,015	315,00	60
T2:	0,020	618,75	86,6
T3:	0,018	337.50	80

UNLOCKING AQUACULTURE POTENTIAL OF ARID AND SEMI-ARID LANDS IN KENYA FOR FOOD SECURITY AND ECONOMIC GROWTH

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Kenya's arid and semi-arid lands (ASALs), which comprise 89% of the country's territory, remain largely untapped for aquaculture despite possessing vast aquatic resources, including permanent rivers, lakes, and reservoirs. This review identifies the potential for aquaculture in ASALs, evaluates key challenges, and proposes actionable strategies by drawing comparisons with Egypt's successful aquaculture sector. The study employed a narrative review of scientific literature and policy documents to assess water resource suitability, climate conditions, and socio-economic barriers to aquaculture expansion. Results reveal that water bodies such as the Tana and Athi rivers, Lake Turkana, and the Seven Forks Dams offer considerable opportunities for aquaculture, especially for Nile tilapia and African catfish. However, development is hindered by fluctuating water levels, pollution, wildlife interference, limited technical capacity, and financial constraints. Drawing lessons from Egypt, the review recommends adopting integrated water resource management, strengthening governance frameworks, enhancing extension services, and investing in infrastructure and local capacity. Innovative models like cage and pond aquaculture, if well-supported, could transform Kenya's ASALs into productive hubs for food security and economic growth. The paper offers practical insights for policymakers, investors, and researchers aiming to promote inclusive, climate-resilient aquaculture in dryland regions.

ASSESSMENT OF GEAR SELECTIVITY OF TRADITIONAL FISH BASKET TRAPS IN LIKONI, KENYA

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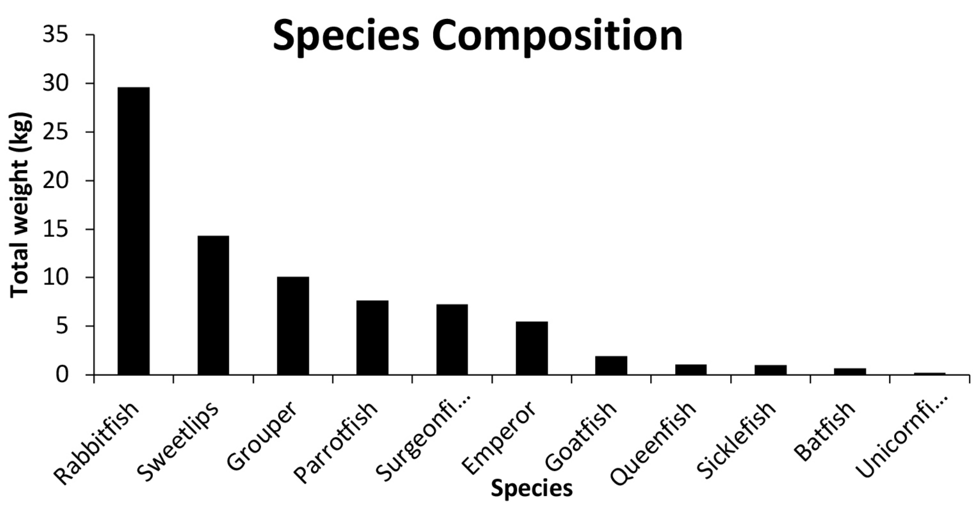
The study was aimed at looking at the selectivity of basket traps in terms of what species were caught, at which sizes and to show the relationship between mesh size and fish size (length). Data collection was carried out at the Likoni landing site where 140 fish were sampled. Most of the catch was dominated by only a few species, including species from the families Siganidae (Rabbitfish), Lethrinidae (Emperors), Serranidae (groupers), Scaridae (parrotfish) and Acanthuridae (Surgeonfish) making up most of the catch. Small mesh sizes caught smaller fish (26-29cm) in contrast to large mesh sizes which caught slightly larger fish (28-39cm). Herbivorous fish including parrotfish, surgeonfish and unicornfish were mostly caught using large mesh sizes (5cm) while commercially important species such as rabbitfish, emperors and goatfish were caught using smaller mesh sizes (3cm).

Basket traps represent a traditional fishing method used in Kenya and other parts of the Western Indian Ocean (Samoilys *et al.* 2011). The dominance of basket traps is not only a common scenario in Kenya but basket traps are both responsible for the majority of fish captured in the Caribbean and around the world (Gobert, 1998; Mahon and Hunte, 2001). The primary reason for their popularity can be ascribed to the low-tech, low-cost and effectiveness of this gear type (Johnson, 2010). They are made of wood and reed strips that are interwoven making hexagon patterns and have one funnel entry.



HEAVY METAL CONTAMINATION IN NILE TILAPIA *Oreochromis niloticus* FROM LAKE ITEZHI-TEZHI, ZAMBIA: IMPLICATIONS FOR AQUACULTURE AND PUBLIC HEALTH

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In Zambia, the rising demand for fish as a vital source of animal protein has increased demand for fish from both aquaculture and wild fisheries. However, increasing pollution from agricultural, mining, and domestic sources has been driven heavy metal accumulation in aquatic environments, threatening public health and the future of aquaculture. This study quantified eight heavy metals: Cadmium (Cd), Cobalt (Co), Copper (Cu), Iron (Fe), Manganese (Mn), Nickel (Ni), Lead (Pb), and Zinc (Zn) in the muscle, liver, kidney, and gills of Nile Tilapia (*Oreochromis niloticus*) from five sites in Lake Itezhi-Tezhi using atomic absorption spectrophotometry. Two-Way ANOVA revealed significant variations ($p < 0.05$) in metal concentrations across sites and organs, as well as their combined effect. The liver and kidney consistently showed the highest metal burdens, followed by gills and then muscle. Principal Component Analysis (PCA) clearly differentiated metal accumulation patterns by site and organ, indicating localised contamination sources. Critically, lead concentrations in fish muscle reached 1.39 mg/kg dw at Nachisenga, and cadmium levels were as high as 0.86 mg/kg dw at the same site, both exceeding the FAO/WHO and EU maximum permissible limits of 0.5 mg/kg dw and 0.05 mg/kg dw respectively. These elevated levels of toxic metals in edible tissues pose a serious risk to human health, especially for populations that consume fish regularly. Moreover, the contamination threatens the sustainability of aquaculture, as the same waterbody supplies broodstock for tilapia and supports downstream aquaculture operations, potentially compromising fish health and food safety. These findings underscore the urgent need for routine environmental monitoring and stricter pollution control measures to protect public health and ensure the long-term viability of aquaculture practices in Zambia.

AQUACULTURE IN LIBERIA: STATE OF PLAY AND GOVERNANCE NEEDS IN A POST-CIVIL WAR CONTEXT

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Liberia's fisheries sector plays an important role in economic growth, livelihoods, and food security. However, the aquaculture sector remains nascent despite development efforts dating back over 70 years. Recently, the Government of Liberia (GoL), in partnership with the World Bank (WB) initiated the Liberia Sustainable Management of Fisheries Project (LSMFP) with a view towards promoting the sustainable development of the aquaculture sector. This study was undertaken to assess the status, challenges, and potential of Liberia's aquaculture sector, and to develop a comprehensive Aquaculture Management Plan and Policy framework that deliberately shifts from previous ambitious approaches to a more focused strategy addressing fundamental issues.

Farm-visits and consultations were held with over 300 stakeholders across six counties. Despite development efforts since the 1950s, current production remains limited (< 100 tonnes). The main cultured species are Nile tilapia (*Oreochromis niloticus*), African catfish (*Clarias gariepinus*), mango tilapia (*Sarotherodon galilaeus*), redbelly tilapia (*Coptodon zillii*), and African bonytongue (*Heterotis niloticus*). Production systems are largely small-scale earthen ponds (200-400 m²) integrated with rice farming. Key constraints include underdeveloped infrastructure, limited access to quality inputs, inadequate technical knowledge, and weak market linkages. These challenges must be understood within Liberia's post-civil war context which severely impacted institutional capacity, infrastructure, and technical knowledge.

The National Fisheries and Aquaculture Policy 2025–2029 aims to address these challenges through strategic pillars including infrastructure development, technical support and capacity building, and creating an enabling environment. The accompanying Aquaculture Management Plan provides operational guidance with protocols for site selection, sustainable practices, and monitoring frameworks. The policy and management plan establish a pragmatic and practical roadmap for unlocking Liberia's aquaculture potential, and may provide useful information for developing governance frameworks in post-civil war contexts in other African nations.

AQUACULTURE IN AFRICAN – IS IT GROWING FAST ENOUGH?

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The 2022 paper coordinated by the University of Bonn and titled *Prospects for Aquaculture Development in Africa – A Review of Past Performance to Assess Future Potential* (Hinrichsen *et al.*) focused on contextualising the aquaculture output of African countries to allow for an depth of understanding beyond an absolute reported tonnage. The current work builds on this and looks at aquaculture growth imperatives in Africa to sustain the current levels of per capita fish consumption.

Africa's population is fast approaching 1.5 billion (2024), making it the second most populous continent after Asia. The average population growth rate has remained above 2.45 percent from the year 2000, and it is expected that Africa will house 2.5 billion people by 2050. This rapidly increasing population results in a rapidly increasing need for food; especially aquatic foods, and specifically foods produced from within Africa. Additionally, the youthful population of Africa needs skills and jobs, both of which can be addressed by an expanded aquatic food sector.

The 2024 yearbook of the FAO indicates that African capture fisheries yield stands at 10 358 thousand tons (FAO, 2021), with aquaculture at 2 322 thousand tons. This means that the contribution of aquaculture to fisheries supply in Africa is a mere 18,3%; in sharp contrast to the rest of the world where aquaculture supply has surpassed that of fisheries. Moreover, if ignoring the contribution of imports and exports, African per capita fish availability stands at less than 8,5 kg per annum; also in sharp contrast to the global average which is approximately 20 kg per capita per annum. As it is well known that capture fisheries, globally and in Africa, has largely reached capacity, Africa has to look to aquaculture to maintain and increase its per capita aquatic food supply.

In this paper we look critically as to whether aquaculture in Africa is growing fast enough and at the rate at which aquaculture needs to increase to (i) maintain and arrest the current declining levels of per capita fish consumption and (ii) to grow African per capita fish consumption to address the current lag behind global consumptions rates.

ADVANCING AQUACULTURE BUSINESS IN THE LAKE VICTORIA BASIN

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The Lake Victoria Fisheries Organisation (LVFO) of the East African Community (EAC) is implementing the European Union-funded TRUEFISH Project towards advancing aquaculture in the Lake Victoria Basin. The project has three main components that deal with aquaculture business, skills and sustainability respectively. Landell Mills have been appointed to lead the aquaculture business development component, which is known as Component 1. Within this component there are three main focal areas, consisting of:

1. Establishing and hosting an East African Aquaculture Exhibition and Conference (EAAEC)
2. Facilitating an increased flow of investment into the sector
3. Supporting regional aquaculture associations (B2B linkage and study tour programmes)

This paper considers the achievements in these areas. The East African Aquaculture Exhibition and Conference was hosted successfully in Kenya in 2023, and in Tanzania in 2024. The current World Aquaculture Safarti’25 in Uganda is the pinnacle achievement in this area and celebrates the TRUEFISH project and aquaculture in East Africa.

To facilitate the flow of investment, TRUEFISH has developed a regional business plan, regional index for aquaculture, supported the establishment of a the East African Regional Aquaculture Association, and developed a map of investors that can be engaged further.

B2B linkages are being established on an ongoing basis, while dedicated B2B training and contact sessions have been hosted in Kenya, Tanzania and at the current conference in Uganda. Associations have also been supported by study tours to Egypt, China and Nigeria.

The results of these interventions are showing as aquaculture in East Africa develops and features on the global stage. This paper considers the impact of high-level interventions and whether this has sector-wide benefits for aquaculture in the region.

PARTIAL AND COMPLETE REPLACEMENT OF FISH MEAL WITH *ARTEMIA* BIOMASS IN THE DIETS OF NILE TILAPIA (*Oreochromis niloticus*)

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Sustainability of Aquaculture industry has been threatened by the high cost of fish feeds, which account for more than 60% of the total operational costs. Fish meal has been used widely as the main source of protein ingredient in the diets of farmed fishes and constitutes the bulk of the cost of fish feed. The recent projected dwindling production of fishmeal signals a progressive increase of fish feed going forward. Artemia biomass which is rich in protein and essential amino acids, and fatty acids could make a suitable replacer for fish meal as the main source of protein. This study compared performance of Nile tilapia fingerlings fed Artemia biomass-based diets prepared by partial and complete replacement of fishmeal (0% Artemia inclusion-AT_0, 50% inclusion-AT_{50} and 100% inclusion-AT_{100}) against an ideal Nile tilapia commercial pellet (COMM). The results show that inclusion of Artemia biomass in tilapia feed resulted in much higher growth parameters as compared to the 0% artemia inclusion diet. The A100 diet foristance produced much higher specific growth rate (SGR) (1.47±0.02%) that was not significantly different from that recorded from fish offered the most favourable diet COMM (1.54±0.00%). Further, fish offered the Artemia-based produced significantly higher survival (AT_{50}=96.44±0.22% and AT_{100}=96.67±0.01%) than that recorded in fish offered the COMM diet (94.44±1.11%). The study concluded that Artemia biomass can completely replace fish meal in the diets of Nile tilapia without compromising the growth performance and feed utilization and recommended similar studies with carnivorous fish.

	Diet[1]				
Parameter	AT_0	AT_{50}	AT_{100}	COMM	**P-value**
Initial length (cm)	12.79±0.06	12.75±0.07	12.74±0.07	12.72±0.07	P=0.131
Initial weight (g fish^{-1})	19.74±1.14	19.26±0.13	20.94±0.12	21.04 ±0.15	P=0.164
Final length (cm)	43.74±0.38	44.10±0.39	43.77±0.38	43.83±0.0.37	P=0.749
Final weight (g fish^{-1})	112.04±1.75^a	124.86±1.90^b	150.21±1.82^c	159.54±2.65^d	P<0.005
SGR (% day^{-1})	1.11±0.02^a	1.23±0.02^b	1.47±0.02^c	1.54±0.02^c	P<0.005
DWG(g day^{-1})	0.81±0.02^a	0.96±0.002^b	1.27±0.02^c	1.38±0.03^d	P<0.005
WG%	157.13±4.67^a	184.76±4.70^b	245.60±4.79^c	268.89 ± 6.75^d	P<0.005
FCR	1.73±0.05^a	1.71±0.06^a	1.44±0.03^b	1.16±0.03^c	P<0.006
Survival %	96.67±1.92^a	96.44±0.22^a	96.67±0.01^a	94.44±1.11^b	P=0.468

HARNESSING THE FUNCTIONALITY OF PROTEINS FROM FISH BY-PRODUCTS TO IMPROVE THE NUTRITIONAL VALUE OF FOODS AND FOOD SECURITY

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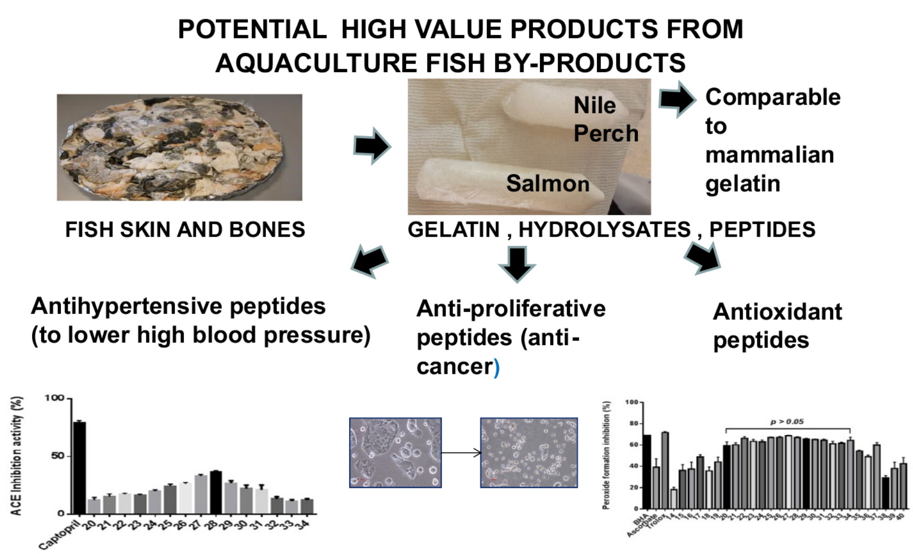
Fisheries by-products, hitherto underutilised, can be used to make novel food products to help combat malnutrition and protein deficiency globally including in Africa. Losses from fish filleting (about 40 %) include head, frames and skin, which can provide valuable protein, lipids and minerals. Additionally, using waste by-products to make value-added, nutritional products (including gelatin, hydrolysates and bioactive peptides) can contribute to the circular economy, whilst reducing pollution.

In this study, collagen and gelatin, widely used as functional and gelling agents in food manufacture and as nutritional supplements were extracted from skin of aquaculture fish species like Nile Perch, Tilapia and Salmon (*Salmo salar*) using acid and alkali, followed by enzymic treatment to produce gelatin. Gel strength values, measured by large and small deformation rheology were compared to mammalian and porcine industry standards. Warm water fish skin gelatin exhibited superior gelling properties compared with those from cold water species, due to differences in the amino acid composition, hydrophobicity and molecular weight.

In addition, gelatin was hydrolysed using enzymes including alcalase, to produce hydrolysates for use as protein supplements. Further, gelatin hydrolysates were broken down enzymatically and purified by chromatography and ultrafiltration to give peptides that exhibited antioxidant as well ACE inhibitory properties and anti-cancer activity in human colorectal cancer cells. The mechanism of activity is elucidated.



MODULATING GROWTH PERFORMANCE, BLOOD CHEMISTRY PROFILE, INTESTINAL AND LIVER HEALTH, DISEASE RESISTANCE AND ECONOMIC EFFICIENCY OF CLIMBING PERCH *Anabas Testudineus* FED ARJUN *Terminalia Arjuna* BARK POWDER

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Arjun bark powder (ABP) is one of the most emerging feed supplements in aquaculture, recognized for its rich bioactive compounds and potent medicinal properties. This present study aimed to evaluate the impacts of graded levels of dietary ABP inclusion on the zootechnical performance, whole-body biochemical composition, blood chemistry, gut and liver morphology, disease resistance, and economic performance of Climbing perch *Anabas testudineus*. Four isonitrogenous diets (35% crude protein) were prepared incorporating ABP at approximately 0% (control, D1), 1% (D2), 2% (D3), and 3% (D4) and fed the fish for 56 days. Fish diets with 1 and 2% ABP had significantly higher palatability compared to other diet groups ($p < 0.05$). Moreover, attractability was noted substantially higher in the 1% ABP diet ($p < 0.05$). Zootechnical parameters in terms of final weight, weight gain, specific growth rate, live weight gain, feed conversion ratio, protein efficiency ratio, hepatosomatic index, and visceral somatic index were significantly improved in the 1% ABP fed fish group ($p < 0.05$). Carcass composition showed that crude lipid content was dramatically reduced in higher levels of ABP ($p < 0.05$), while crude protein, ash, and moisture did not exhibit any variations ($p > 0.05$). Different levels of ABP had notable effects on several hemato-biochemical indices of fish ($p < 0.05$). Different levels of ABP showed significant improvement in *A. testudineus* liver and gut health. The percent survival was the highest achieved in the D1 treatment (76.67%), with control fish having the lowest survival (30%) when challenged upon *P. aeruginosa*. Economic efficiency was significantly enhanced in the D1 group rather than in other test groups ($p < 0.05$). To conclude, incorporating ABP up to 1% in fish diets demonstrated better growth and health performance, body physiology, disease resistance, and economic efficiency.

MOLECULAR IDENTIFICATION AND NUTRITIONAL PROFILING OF SOME COMMERCIALLY IMPORTANT MARINE FISHES OF PAKISTAN

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This study investigates the genetic-based identification and nutritional composition of 5 important marine fishes: *Trichiurus lepturus*, *Sillago sihama*, *Acanthopagrus arabicus*, *Otolithes cuvieri*, and *Nemipterus japonicus* sampled from supermarkets of Lahore, Pakistan. The fish species identified by using mitochondrial 16S rRNA gene (350 bp). NCBI-BLAST confirmed the 100% identification of the sampled fishes using genetic sequences from the NCBI GenBank database. The standard protocol of the Association of Official Agricultural Chemists (AOAC and ICPOES) was used to determine the proximate composition and mineral content. The study's findings demonstrated that every sample had a significant variation ($p < 0.05$). *Acanthopagrus arabicus* had highest protein content (18.4%), while *Nemipterus japonicus* had the lowest (14.9%). The crude fat was found highest in *Acanthopagrus arabicus* wherease lowest in *Nemipterus japonicus*. The range of the moisture content was 74.8 to 76.3%. The average ash content of each fish ranges from 1.6% to 2.0%. *Otolithes cuvieri* had the lowest calcium level (1621.17 mg/kg), whereas *Trichiurus lepturus* had the highest (1793.09 mg/kg). The magnesium content ranged between $1722.93{\pm}122.95^{d}$ and $2087.31{\pm}87.24^{a}$. All fish species had comparatively lower levels of zinc, potassium, sodium and iron and all of the results were within the recommended ranges defined by the WHO and FAO. This is the first report on identification from Pakistan in the Arabian Sea based on morphology and DNA analysis. For aspiring biologists, DNA-based identification methods provide an important analytical supplement or perhaps a potential replacement for inventory. The marine fishes can be excellent source of an important nutrients and may provide more health advantages to people.

FISH PREFERENCES AMONG INSTITUTIONAL CONSUMERS IN LAKE VICTORIA CRESCENT UGANDA

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Fish has become popular worldwide and one of the mostly consumed foods. It is an important food for over 400 million Africans, contributing essential proteins, minerals and micronutrients to their diets. Despite this, Sub Saharan Africa has the lowest per capita fish consumption in the world (11.2 kg/ per capita) compared to 19.0 kg per capita in the world. In Uganda fish consumption is estimated at 14.3kg per capita. Studies on fish consumption in Uganda focusing on institutions such as hotels/restaurants consumption are limited and yet they are an important actor in fish value chain. The main objective of the study was to gather information on institutional fish buyers' requirements with a view to inform fish breeders to provide tailored products and ultimately enhance the market share of the fish sector in Uganda.

Methodology: The study was conducted in Victoria crescent which was purposively selected due the high number of registered institutions (Hotels & Restaurants). The sample unit was the formal functional hotel/restaurant serving fish. A sample size of 603 was selected based on Cochran (1963) formula. Data were collected using structured questionnaires supplemented by information obtained from secondary literature.

Findings: The results show that these institutions on average serve 42 customers out of which only 14 eat fish.

There was a strong agreement among restaurant managers across all surveyed locations against serving farmed fish, with opposition rates ranging from about 62.9% to 68.6%. This is because the majority of institutions (73.9%) cited farmed fish as being less tasty, while 39% citing customers as preferring wild fish and 15.6% citing poor texture. The challenges the institutions faced were very expensive fish (80.7%) followed by limited fish supply 53%.

This implies that a lot of effort will be required to increase the supply of fish both from aquaculture and the wild.

Table 1: Profiles of Hotels/ Restaurants

Variables	Jinja	Masaka	Entebbe	Kampala	Total
Number of Employees /Waiters	14.8	7.5	6.9	9.4	9.7
On average number of customers served in a day	36.2	36.2	40.4	46.9	42.0
Number of customers who eat fish on average per day	12.8	13.3	16.6	13.3	13.8
Years of the facility operating	11.84	8.67	9.23	8.39	9.26

Table 2:Managers response to Serving of Farmers fish in the hotels/restaurants

Responses	Jinja (n=116)	Masaka (n=94)	Entebbe (n=110)	Kampala (n=287)	Total (n=607)
No	62.9	63.8	66.4	68.6	66.4
Yes	37.1	36.2	33.6	31.4	33.6

Source: Buyer's requirement for fish survey 2022

DETERMINANTS OF POST HARVEST LOSSES AMONG FISHERS ALONG THE LAKE VICTORIA CRESCENT REGION, UGANDA

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Uganda's fisheries sector is dominated by small-scale fishermen, from whom large processors or traders consolidate fish for local consumption or for export. The post-harvest activities of small fishers and losses incurred often receive less attention. They frequently involve use of low technology, labour-intensive fishing activities, and relatively low capital investments.

This study aimed at estimating the major causes of fish losses among small-scale fishers so as to develop guidelines for better fisheries handling. It surveyed over 30 landing sites involving 79 fishers sampled along in the Lake Victoria crescent region. Common methods were employed to assess post-harvest losses, and fractional regression was utilized to identify key factors contributing to these losses

Fishing was dominated by men(97%) with only 3% being women. The most predominant fish species caught by fishers was Nile perch (51%), followed by Tilapia (37%) and silverfish (13%). Fishers used the following methods to preserve their fish.; keeping the fish in ice (42%), deep frying (21%), quick/timely selling (18%), sun drying(18.5%), smoking (8%) proper packaging in boxes(5%) refrigerating (1.3%) and salting (3.2%). Despite use of preservation methods, losses still occurred among the value chain actors. Physical post-harvest losses among fishers stood at between 4% to 33%.. The Key factors influencing post-harvest losses were fishing experience, use of ice, training received and type of fish species

The constraints they experienced included fish price fluctuations, restrictions by protection unit, expensive fishing gear and lack of ice or limited storage facilities for fish. There is a clear need to promote more training on fish handling, promoting use of ice and the set-up of proper fish handling facilities in order to stem the post-harvest losses occurring among fishers.

Table 1 : Determinants of fish Post- Harvest losses

Parameters	Coefficient	S E	p-value	Margins
Age of respondent	-0.0202	0.0158	0.201	-0.0622
Education	0.0035	0.3187	0.895	0.0020
Gender	-0.0575	0.0271	0.857	-0.0046
Fishing Experience (Yrs)	-0.0371	0.0142	0.009***	-0.0423
Use of Ice	-1.6083	0.3335	0.000***	-0.0471
Training	-1.1688	0.2304	0.000***	-0.0364
Wash fish	-0.2010	0.2304	0.383	-0.0080
Frequency of fishing	-0.0026	0.0115	0.819	-0.0050
Predominant Species	0.2103	0.1005	0.036**	0.0380
Constant	-2.2387	0.5251	0.000***	

MICROBIOLOGICAL QUALITY AND HEALTH EFFECTS OF HEAVY METALS IN WATER, SEDIMENT AND PRAWN *Melicertus plebejus* FROM THE ABEREKE RIVER, ONDO STATE, NIGERIA

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The Abereke River, situated in Araromi, Ondo State, Nigeria, plays a vital role in supporting a diverse range of species and providing important seafood resources, especially prawns (*Melicertus plebejus*), for the local population. Unfortunately, increasing human activities, particularly oil exploration and urbanization, have raised concerns about the ecological health and safety of these aquatic resources.

This study aimed to assess the microbiological quality, proximate composition, and concentrations of selected heavy metals; lead (Pb), zinc (Zn), manganese (Mn), copper (Cu), mercury (Hg), and cadmium (Cd), in samples of water, sediment, and prawns collected from the Abereke River. Microbial analyses were conducted using the pour plate method to determine total viable counts (TVC) and utilized membrane filtration for *Enterobacteriaceae*, following standard protocols. The proximate composition of prawn tissues was analyzed using standard procedures. Heavy metal concentrations were measured using Atomic Absorption Spectrophotometry (AAS).

The results indicated that the TVC and *Enterobacteriaceae* counts in both prawn and water samples fell within acceptable ranges, reflecting satisfactory microbiological quality. The proximate analysis of prawns showed a moisture content of 10.51 ± 0.01%, crude protein at 73.83 ± 0.07%, ether extract at 4.23 ± 0.01%, ash at 10.12 ± 0.01%, and carbohydrate at 1.22 ± 0.01%, indicating a high nutritional value. In the water samples, manganese was detected at 0.36 ± 0.02 mg/L, exceeding the WHO permissible limit of 0.1 mg/L, while other metals were absent. Sediment analysis revealed zinc levels at 33.60 ± 2.00 mg/kg, surpassing the permissible threshold of 0.6 mg/kg, while copper levels were within acceptable limits at 0.01 ± 0.00 mg/kg; mercury, lead, and cadmium were undetected. Prawn tissues showed zinc and manganese levels at 76.55 ± 4.00 mg/kg and 28.70 ± 0.12 mg/kg, respectively, both exceeding the FAO/WHO maximum allowable limits of 30 mg/kg for zinc and 1 mg/kg for manganese, while copper was acceptable at 0.40 ± 0.01 mg/kg; mercury, lead, and cadmium were not found.

These findings portray the effect of human activities on the Abereke River ecosystem, with elevated heavy metal levels posing potential health risks to consumers and threatening aquatic biodiversity. While the microbiological quality seems satisfactory, the presence of heavy metals reveals the necessity for continuous monitoring and stringent environmental regulations to safeguard the ecosystem. The results also suggest the potential for sustainable aquaculture development in the area, provided that environmental pollutants are effectively managed to ensure the safety and quality of aquatic products.

DEFATTED AFRICAN PALM WEEVIL LARVAE REPLACED 50 % OF FISH MEAL IN THE DIETS OF AFRICAN CATFISH

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Fish meal is scarce and expensive; therefore, there is a search for cheaper alternatives that promote fish growth without compromising physiological functions. African palm weevil (*Rhynchophorus phoenicis*) larvae, which contain approximately 63% crude protein, may serve as a suitable alternative. Defatting the larvae increases protein levels, maintains a good amino acid profile, boosts mineral content, and reduces oil content, making it an excellent option for producing low-fat food fish. This study, therefore, investigated the effects of partially replacing fish meal with defatted palm weevil larvae meal in the production of African catfish, *Clarias gariepinus*.

African palm weevil larvae were procured from a commercial vendor, defatted, and blended into a fine semi-powder to create a meal. This meal was used to replace fish meal at 0, 20, 30, 40, and 50% in the diets provided to African catfish juveniles. Feeding continued for 56 days, after which biometry was conducted. Samples of fish from each treatment were randomly collected to determine carcass values and various biochemical profiles of the fish.

Results indicated no significant differences in mean weight gain and specific growth rate between fish fed 100% fish and those fed diets containing up to 50% defatted palm weevil larvae meal (Table 1). Carcass analyses also revealed similar ($P > 0.05$) characteristics in protein deposition, ash composition, and carcass lipid. However, carcass lipid decreased slightly with increasing levels of defatted palm weevil meal in the diets. Furthermore, the biochemical profile showed that dietary palm weevil increased superoxide dismutase and total protein while reducing alanine aminotransferase and aspartate aminotransferase. In conclusion, defatted palm weevil larvae could replace up to 50% of fish meal in the diets of African catfish.

Table 1. Growth of African catfish fed defatted palm weevil (PW) in replacement for fish meal

Parameters	Diet 1 Control	Diet 2 (20 % PW)	Diet 3 (30 % PW)	Diet 4 (40 % PW)	Diet 5 (50 % PW)
Initial Weight (g)	4.47 ± 0.0^a	4.74 ± 0.4^a	4.81 ± 0.1^a	4.87 ± 0.2^a	4.50 ± 0.2^a
Final Weight (g)	36.3 ± 0.4^a	37.1 ± 0.3^a	36.9 ± 0.0^b	39.4 ± 0.3^b	37.8 ± 0.0^a
Mean Weight gain (g)	31.8 ± 2.7^a	32.4 ± 2.9^a	32.1 ± 2.9^a	34.5 ± 3.0^a	33.3 ± 0.9^a
Specific growth rate	3.22 ± 0.0^a	3.16 ± 0.0^a	3.13 ± 0.3^a	3.22 ± 0.1^a	3.27 ± 0.0^a
Feed conversion ratio	1.27 ± 0.0^a	1.35 ± 0.1^a	1.34 ± 0.1^a	1.32 ± 0.0^a	1.40 ± 0.0^a

CAN INNOVATIVE SERVICE DELIVERY MODELS GROW SMALLHOLDER FISH FARMING?

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As Africa's aquaculture industry develops, the role of smallholder fish farmers is questioned. Smallholder development initiatives often fail to realise impact past the project end date, and development organisations are increasingly looking towards large-scale, international investment-driven businesses as the future of fish farming. Yet, smallholders play a critical role in aquaculture value chains and can provide significant livelihood benefits in rural areas. Service delivery models can provide structured opportunities for smallholders to be included in increasingly formalised supply chains through equitable access to inputs and clear routes to market and effective technical support.

This presentation will describe the results and impact of one such model: an innovative, award-winning approach that goes back to basics has been trialled in Rukungiri in western Uganda, with potential applicability across the African aquaculture industry where smallholders are critical to local supply chains. Unlike donor-driven models that dwindle post-project when funding is exhausted, the approach has been developed as a financially-viable business and supports the development of many other local small and medium enterprises (SMEs). This is a viable, investable business model that relies on understanding local opportunities and responding to the needs of the local market.

The model centres around a local hub that provides the essential inputs for a network of local farmers and, crucially, offers to buy the fish back from farmers and supply into local markets. Hub owners reinforce activity across the value-chain by developing local markets – by ensuring that fish is consistently supplied to markets, consumers gain confidence that fish will be available when they want it. The pilot hub in Rukungiri has been testing consumer preferences for different sizes of fish at different price points, enabling even the poorest consumers to access nutritious food.

Based on local needs, the hub can produce feed and fingerlings, or serve as an aggregation point for supplies from other local companies. The hub also produces its own fish to smooth out supplies to market. The pilot hub has brought innovation in cold chain technology, feed, and production approaches that stretch beyond the core business. Technical support is provided to ensure that farmers can succeed in their own production, which in turn further strengthens local supplies.

Due to the success of the pilot hub, the vision is to create a network of hubs that can support thousands of SMEs and provide millions of nutritious meals to rural African communities. The pilot Hub has demonstrated that this model is an effective, profitable business that is investable, scalable and adaptable to local conditions; and by responding directly to industry and market demands, has the potential change millions of livelihoods.

GENETIC IMPROVEMENT IN TILAPIA (*Oreochromis niloticus*) AND THE AFRICAN CATFISH (*Clarias gariepinus,* Butchell, 1822)

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The Nile Tilapia *(Oreochromis niloticus)* and the African catfish (*Clarias gariepinus)* are the two most cultured fish species in Africa. Genetic improvement in these fish species, specifically the Nile tilapia has resulted in significant gains in the past few decades. This is particularly true for the Genetically Improved Abbassa Nile Tilapia (GIANT) developed in Egypt and the Genetically Improved Farmed Tilapia (GIFT) developed by the WorldFish, which reported up to 20% gain in growth rate per generation (Yáñez et al., 2020; Hamzah et al., 2014). The GIFT strain has been distributed to several countries such as Bangladesh, China and recently, Nigeria. Genetic improvement in the African catfish has shown an accumulated gain in growth rate of up to 50% in over three generations in Indonesia (Imron et al., 2020). There is yet a successful genetic improvement programme for *C. gariepinus* in Africa, however, the Dutch-domesticated strain of the African catfish has been reintroduced to Africa, particularly Nigeria and some other countries such as Kenya, Uganda, South Africa.

The distribution of the GIFT tilapia and the Dutch *Clarias* to other countries is often met with concerns over the ecological impact upon native populations (Ansah et al., 2014; Eknath & Hulata, 2009). Of even more concern is the fate of such stocks post-reintroduction. In the case of the African catfish in Nigeria, the dert in knowledge on genetic management of broodstock in various hatcheries, the mating designs, sex ratios, the use of shooters as broodstock and reliance on very few initial populations has led to very low levels of genetic variation within and between farms. Results from a survey on hatchery practices show that no hatchery operator tagged his/her broodstock and broodstock from different sources are often mixed together without any means of identification. Only 3% of the respondents used sex ratios of 1:1 as 97% used skewed sex ratios (between 1:2 – 1:5). A total of 76% of the respondents used shooters as broodstock and 68% also reuse their broodstock at least three times in a year. Using DArTSeq, a next generation sequencing technology, the observed heterozygosity recorded from a study conducted by the author, to assess levels of inbreeding in 33 farmed and 2 wild populations of *Clarias gariepinus* in Nigeria involving 276 individuals and 6797 loci was 0.0802, while the expected heterozygosity was 0.09. Many farmers now report poor survival, poor and uneven growth and increased skeletal deformities, most of which they attribute to inbreeding depression.

Today, inadequate supply of good quality fish seeds is one of the major problems of the Nigerian catfish aquaculture industry. While the tilapia industry in Nigeria is still young, the possibility of trailing the part of the African catfish is not completely uncertain. There is therefore the need for the evaluation of different strains of tilapia and *C. gariepinus* for suitability in aquaculture in Nigeria, and assess their genetic relatedness to ensure biodiversity.

This should then be followed by establishing a genetic improvement programme through markers assisted selective breeding programmes that could benefit from genomic selection using SNPs panels.

ENHANCING MARKET OPPORTUNITIES THROUGH PARTICIPATORY GUARANTEE SYSTEMS (PGS) IN ASSAM'S AQUACULTURE SECTOR: IMPACTS, CHALLENGES, AND STRATEGIES

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This study explores how Participatory Guarantee Systems (PGS) improve market performance and consumer awareness in Assam's freshwater aquaculture sector. By providing affordable, locally-focused certification, PGS helps small-scale fish farmers build consumer trust and boost the credibility of naturally farmed fish. Field observations and survey data reveal that over 75% of participating farmers experienced significant income growth, with 35–45% higher farm gate prices attributed to positive word-of-mouth. Nearly half of the respondents reported improved market access and greater recognition for their produce, reflecting a rising consumer preference for chemical-free, sustainably produced fish.

Despite these gains, challenges persist, including limited branding, restricted access to premium markets, and logistical barriers such as inadequate cold chain and live fish marketing infrastructure. Addressing these constraints is crucial for expanding market reach and sustaining farmer profitability. Awareness campaigns under the Indo-German Development Cooperation project, "Food Security Through Integrated Aquaculture (EIAA)," locally known as "Sustainable Aquaculture for Food and Livelihood (SAFAL)," have played a pivotal role in supporting the cause and initiative through local partners. The project has also helped farmers position PGS-certified products as reliable options for naturally produced fish. The study highlights the transformative effect of PGS on farmer livelihoods, market opportunities, and consumer trust. It advocates for targeted interventions to strengthen branding, upgrade market infrastructure, and deepen consumer engagement, ensuring the long-term success and scalability of PGS initiatives in Assam's aquaculture sector.

AQUACULTURE BUSINESS SCHOOL (ABS): IMPLEMENTATION IN THE INDIAN CONTEXT

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The implementation of the Aquaculture Business School (ABS) in India, spearheaded by GIZ Sustainable Aquaculture for Food and Livelihood (SAFAL) in collaboration with local and Global partners, represents a transformative approach to empowering rural aquaculture communities. Drawing inspiration from the Agri-Business Facility (ABF) model successfully applied in Africa, the initiative incorporates localized adaptations for the Indian aquaculture sector. The ABS initiative began with a vision-sharing workshop involving diverse stakeholders such as the Department of Fisheries (DoF), Assam, Assam State Rural Livelihood Mission (ASRLM), and other allied institutions. A key highlight was the step-by-step process presented by ABF experts, emphasizing the recruitment of master trainers, structured Training of Trainers (ToTs), and field demonstrations. The program integrates adult learning principles, resource-efficient practices, and participatory rural appraisal (PRA) approach. Key milestones include the selection of 15 trainers from Assam's intervention Districts, integrating them into a comprehensive training pipeline, and adapting training materials for local contexts. Learning from the African ABF model, the Indian program employs a paper-based system and emphasizes community-driven evaluation methods. The program identified carp, rice, and duck as focus components for implementation, reflecting Assam's agrarian landscape. A knowledge product involving didactics was also developed.

Outcomes of the initiative encompass enhanced training frameworks, joint agreements on budgets and operational plans, and tailored strategies to meet local needs. The ABS approach demonstrates a scalable pathway for transforming traditional aquaculture to aquaculture business development model in India, fostering sustainability, capacity building understanding on risks and finding mitigation measures, business decision making and economic empowerment.

SUSTAINABLE AQUATIC FOOD SYSTEMS TRANSFORMATION WORKSHOP COMMUNIQUÉ HELD ON THE 15TH OF OCTOBER 2025

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Aquatic food systems play a critical role in supporting food security globally, with many people depending on these systems for nutrition and livelihood development through job opportunities in different value chains in the fisheries sector. The potential of these systems has been derailed by several challenges, including climate change, human factors like overexploitation of resources, and unavailability and access to aquatic foods, in addition to limited markets. Food security can only be achieved if we have a safe, steady, and healthy supply of food that meets the needs of consumers. Through workshop discussions that brought together diverse stakeholders and employed different methodologies, this paper seeks to understand and bring to light these challenges and how best to mitigate the shortcomings that lead to the under-recognition as well as underperforming of aquatic food systems compared to other food systems despite their nutritional significance. The communique on the "Sustainable Agri-Food Systems Intelligence – Science-Policy Interface" (SASi-SPi) was organized in partnership with various research/ academia, stakeholders in the blue economy sector, and hosted by the Kenya Marine and Fisheries Research Institute (KMFRI). After a strong two-day session involving the pitching of ideas from different individuals, consensus was reached on the resolutions that will drive the agenda of the aquatic food systems forward. The session was unique since it was community-centered, with the policy influencers giving more airtime to the small-scale fishers to articulate the challenges they termed perennial in the industry and voting to bring equity into play. The strategic recommendations included making finances that are sustainable finances available, enhancing the capacity of non-fishing communities to consume aquatic value-added products by taking advantage of sensitization and campaigns, leveraging technology to develop the sector, and promoting gender inclusion, allowing women to have seats on the decision-making table. Through the integration of equitable access, nutrition value, and sustainable resource usage in aquatic food systems, we can provide transformative action aimed at sustainably using our aquatic systems.

ONE HEALTH AQUACULTURE

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The world has come to acknowledge that the health and welfare of mankind is interconnected with the health and welfare of animals, plants and the environment as a whole. As such, the productivity, quality and safety of products derived from terrestrial or aquatic animal resources depends on the level of harmonious synchrony sustained between these components, the circular economy. This presents a paradox for the world's rapidly aquaculture sector, that is rapidly growing and transforming while at the same time aquatic ecosystems are in a state of flux due to environmental and climate changes. The pivotal role played by aquatic ecosystems for life on earth, present key questions as the aquaculture sector seeks to transform into a sustainable yet resilient blue food system that contributes comprehensively to human welfare and SDG14 'Life Below Water'. The questions and opportunities at hand consequently infer that aquaculture need become intrinsic to One Health, as opposed the current situation where the application of One Health in aquaculture, is largely as an external intervention to safeguard the health, welfare and safety of farmed aquatic animals and their products for economic gain. Can the global status of information, knowledge, technology and training and education enable us achieve this?

THE ELEVENTH TECHNICAL COMMITTEE MEETING OF THE AQUACULTURE NETWORK FOR AFRICA

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In 2023, the 5th Ordinary Session of the African Union's Specialized Technical Committee (STC) on Agriculture, Rural Development, Water and Environment (ARDWE) endorsed the Aquaculture Network for Aquaculture (ANAF) as an African Union (AU) platform of Directors of Aquaculture whose role is to support, facilitate, coordinate and promote the establishment of partnerships, including with Africa's Non-State Actor Networks, for the coherent implementation of AU policies and strategies to promote sustainable aquaculture development in Africa. The African Union Interafrican Bureau of Animal Resources (AU-IBAR) serves as ANAF's Secretariat.

Africa's blueprint for the sustainable development of its fisheries and aquaculture sector is the Policy Framework and Reform Strategy for Fisheries and Aquaculture in Africa (PFRS). The continental mechanism for the implementation of the PFRS is the Africa Fisheries Reform Mechanism (AFRM). The AFRM adopts broad-based all-inclusive participatory to support AU's Member States, Regional Economic Communities and the private-sector strengthen policy coherence towards enhancing the role of fish in food and nutrition security, livelihood, employment, wealth creation and socio-economic by anchoring on the CAADP and Africa's regional economic integration agenda.

As Africa's apex forum where both public and private-sector stakeholders share information and best practices on policy and technologies to promote sustainable aquaculture development in Africa, ANAF consequently undertakes to coordinate and facilitate the development and establishment of public-private partnerships on Sustainable Aquaculture Development with *One Voice*, under the umbrella of the AFRM. ANAF is therefore organising it 11th Technical Committee meeting at WA25 to consolidate an all-inclusive Africa common Position from the experiences and lessons learned by Africa's multiple aquaculture stakeholders.

THE REGIONAL AQUATIC ANIMAL HEALTH NETWORKS FOR AFRICA: NORTH AFRICA AND SOUTHERN AFRICAN DEVELOPMENT COMMUNITY

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Background
AU-IBAR in collaboration with WOAH supported the launch of the Regional Aquatic Animal Health Network's (RAAHN) for Southern and North Africa in 2023. The establishment of RAAHN's is among the key outputs of the EU supported second Fisheries Governance Project on improving regional capacities for aquatic disease outbreak detection, notification and coordinated response with a view to enhancing safe intra and inter regional fish trade in line with the regional integration trade agenda and the Protocol on Trade in Goods of the Africa Continental Free Trade Area. Additionally, the action is also in concurrence with the WOAH's Aquatic Animal Health Strategy (2021-2025).

The RAAHN's offer an opportunity for establishing an all-inclusive multi-stakeholder participatory mechanism through which the sectors stakeholders collaborate equitably, to share sanitary information. This is a proven global and continental best practice that has been shown to promote coherence and cost-effectiveness in the development and implementation of animal SPS standards and measures, and thus promoting the sustainable development of animal (aquatic animals notwithstanding) value-chains. The approach further aligns with the Policy Framework and Reform Strategy for Fisheries and Aquaculture in Africa (PFRS) and the Africa Fisheries Reform Mechanism (AFRM). The action will ultimately promote aquatic animal health governance to safeguard Africa's aquatic animal resources against biological threats, enhance the productivity and resilience of its fishery and aquaculture production systems, foster aquatic biodiversity conservation, and enhance the competitive access to markets for Africa's aquatic animal resource goods and services. This is paramount for the development sustainable food systems.

The occasion to conduct the first steering committee meetings for RAAHN North Africa and SADC as a side-event at World Aquaculture 2025 offers committee members an opportunity to draw and share lessons from global and regional experiences.

AQUACULTURE ON THE RISE: AFRICA'S PERSPECTIVE

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Continental concern over the poor performance of Africa's fisheries and aquaculture sector in the Comprehensive Africa Agriculture Development Programme (CAADP) prompted Africa's convening of the *Fish for all Summit* in Abuja, Nigeria in 2005. To address the, the *Summit* recommended strategic investments to improve the management of natural fish stocks, develop aquaculture production and enhance fish trade in domestic, regional and global markets. Africa's Heads of State and Government (AHSG) accented to this recommendation in the *Abuja Declaration on Sustainable Fisheries and Aquaculture (2005)*. Consequently, the Policy Framework and Reform Strategy for Fisheries and Aquaculture in Africa (PFRS) was developed and adopted as the blue print for transformation of the sector by AHSG in 2014. The PFRS consists of seven policy pillars and the modality for its implementation is an all-inclusive participatory process, the African Fisheries Reform Mechanism (AFRM).

The third policy pillar of the PFRS is 'sustainable aquaculture development'. The aims to harness the full potential of Africa's aquaculture sector sustainably, to generate wealth, social benefits and contribute to the development of Africa's economy by jumpstarting market-led sustainable development strategies. These strategies outlined are creating an enabling environment, creating African Centre of Excellence for Aquaculture, mainstreaming aquaculture strategies and plans into national development plans especially CAADP, and increasing research and dissemination of better practices. The anticipated outcomes are market-led aquaculture investments operating in many countries, accelerated growth rates, the enabling environment for investment and governance significantly improved, public-private-partnerships in aquaculture development significantly strengthened, strategic cooperation in many areas of aquaculture regionally, harmonised and coherent policies, institutional and legal frameworks for aquaculture in shared ecosystems.

In line with the AFRM, an all-inclusive bottom-up participatory continental consultative process commenced in 2015 under to draft a implementation framework by consensus. This culminated into the drafting of a continental action plan at a continental aquaculture think tank meeting in 2016. The draft was consolidated by AFRM's Aquaculture Working Group for further consultation with the global community at the 32nd Session of the FAO Committee on Fisheries (COFI) in 2016. Thereupon, the AHSG adopted the *'AU Ten Year Aquaculture Action Plan 2016-2015'* as the PFRS companion document outlining the approach for promoting.

The session presents and reviews the performance of *AU Ten Year Aquaculture Action Plan 2016-2015'* for the sectors development over the last decade in Africa. As a result, it aims to draw lessons to chart the way forward for the next decade of aquaculture development in Africa, under CAADP Strategy and Action Plan: 2026-2035 that aims to strengthen the resilience of Africa's agri-food systems.

THE STATUS AND PROSPECTS FOR STRENGTHENING AQUATIC ANIMAL LABORATORY DIAGNOSTIC SERVICES IN AFRICA

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The AU Policy Framework and Reform Strategy for Fisheries and Aquaculture in Africa (PFRS)[1] advocates holistic transboundary aquatic ecosystem approaches following international and regional best practice, for the continent's management of natural fish stocks, sustainable aquaculture development, and fish trade in domestic, regional and global markets. However, threats to the sector's sustainability, emanating from emerging transboundary aquatic animal diseases (TAADS), environmental degradation, climate change and demographic changes are increasingly evident. The African Union Commission (AUC) has consequently tasked its lead technical agencies, the Interafrican Bureau of Animal Resources (AU-IBAR)[2] and Pan-African Veterinary Vaccine Center (AU-PANVAC)[3] to strengthen Africa's continental capacity for aquatic animal health and aquatic biosecurity control for: the early detection, accurate reporting and control of the spread of aquatic animal diseases, pests and invasive species; control acquisition and spread of aquatic antimicrobial resistance through aquatic animal food-production systems; the development and use of effective alternatives to antimicrobial agents to safeguard health, welfare and safety of Africa's aquatic animals and their products; and for compliance to the World Trade Organization's sanitary and phyto-sanitary measures. Diagnostic laboratory services are a pre-requisite for achieving this.

A continental online survey to assess the status and prospects for establishing three-tier regional laboratory information management systems involving both public and private-sector stakeholders to generate and share accurate and credible sanitary data and information in a timely manner, was consequently commissioned in 2023. The preliminary findings of the survey, are hereby shared.

1. https://au.int/web/sites/default/files/documents/30266-doc-au-ibar_-_fisheries_policy_framework_and_reform_strategy.pdf
2. https://www.au-ibar.org/
3. https://au.int/en/articles/aupanvac-plays-critical-roles-quality-control-vaccines-africa

MAPPING THE PRODUCTION, DISTRIBUTION AND USE OF AQUATIC ANIMAL VACCINES IN AFRICA

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The sustainable development and growth of Africa's fisheries and aquaculture sector depends on the extent to which, the sector's biological, environmental and socio-economic attributes can be managed and utilized to materialize into the production of safe aquatic foods, goods and services for local communities and trade. This is clearly spelt out, by the African Union's Policy Framework and Reform Strategy for Fisheries and Aquaculture in Africa (PFRS) that was endorsed as the continent's blue print for the sector, in 2014. The implementation of the PFRS is transforming the sector into one that is more productive and robust. Volumes of production and regional fish trade are increasing, particularly within aquaculture sub-sector. The diversification of production systems and expansion to value-chains to take advantage of expanding local and emerging regional markets has not come without challenges.

There are growing concerns over increased reports of aquatic animal disease outbreaks, the safety of aquatic animal products, antimicrobial resistance, occupational health and environmental impacts for the sustainable development the sector and access to markets in both the fisheries and aquaculture sub-sectors. This in part accrues to the fact that Africa's major commercial aquaculture species, are also its major commercial fisheries species and the interconnectedness of Africa's freshwater and marine ecosystems. Africa's commercial aquaculture and fisheries production both occur within these interlinked aquatic ecosystems, often within the same water bodies using open and/or semi-open production systems. Taking this into account, any interventions to safeguard aquatic animal health and welfare such as for disease control, hinge a lot on ensuring biosafety and aquatic ecosystem health within respective water basins. Thus in 2024, the African Union Commission opted to assess the prospects of aquatic animal vaccines as a measure for the control of aquatic animal diseases upon further considering continental guidance offered by the Animal Health Strategy for Africa, the Animal Welfare Strategy for Africa and the African Union Framework for Antimicrobial Resistance Control 2020–2025. It consequently tasked AUIBAR and AU-PANVAC to assess the status, and coordinate the development of a continental strategy to guide the production, use, distribution and trade of safe aquatic animal vaccines in Africa. This presentation shares preliminary findings on the status and stakeholders' views towards establishing a bio-secure aquatic animal vaccine chains and programs in Africa.

STRENGTHENING THE CAPACITY AQUATIC ANIMAL HEALTH AND BIOSECURITY CONTROL IN AFRICA

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Africa's fisheries-aquaculture sector is extremely diverse and covers a wide range of ecological and socio-economic contexts ranging from coastal and inland artisanal fisheries, high sea fisheries, freshwater and marine aquaculture. The sector is dominated by small-scale fisheries (SSF) that rely on traditional methods to harvest and process fish into products that are then distributed through informal fish trade. As a result of informal fish trade, the sector supplies fish to over 200 million consumers and directly employs over 10 million people on the continent. It is estimated that more than 40% of all fish harvested crosses a border between the point of production and the place of consumption through this trade, making fish, the second most traded agricultural commodity after sugar on the continent. Improving access to regional markets therefore offers Africa's fisheries and aquaculture sector, one of the best alternatives to expanding economic opportunities and earnings across the sector's value chains, the adoption of best sectoral practices amongst the sectors stakeholders, the reduction post-harvest fish losses and enhancing food and nutrition security. However, this cannot be achieved unless fish producers, AU-MS and REC's adopt harmonized standards that ensure the safety of fish and fish products for human consumption and other uses; as well as prevent the spread of aquatic animal diseases, pests and invasive species between aquatic ecosystems and across borders. The Policy Framework and Reform Strategy for Fisheries and Aquaculture in Africa advocates the adoption of the WTO's Sanitary and Phyto-Sanitary Agreement, as the denominator for developing and harmonizing regional standards to facilitate safe and equitable fish trade in Africa.

In order to safe-guard aquatic biodiversity, fisheries and aquaculture production and productivity; improve access to markets, foster aquatic-food safety and public health, aquatic biosecurity and biosafety, aquatic ecosystem health and environmental sustainability, in 2023, the African Union Commission commissioned the development of a continental Aquatic Animal health Strategy to strengthen continental capacity for the control of aquatic animal diseases, pests and invasive species.

that highlighted. This will facilitate multisectoral ad intraregional cooperation and collaboration for the establishment of harmonized approaches for implementing WTO's Sanitary and Phyto-Sanitary Agreement to enhance across Africa's transboundary aquatic ecosystems and fisheries and aquaculture value chains. This paper shares the status and the prospects in Africa's approach for establishing all-inclusive risk-based regional approaches to promote the volaristaion and resilience of Africa's regional fish value chains, equitably and sustainably.

THE AFRICAN UNION AQUACULTURE ACTION PLAN 2016-2025: WHAT IMPACT HAS IT HAD ON THE TREND OF AQUACULTURE DEVELOPMENT IN AFRICA?

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Modern-day aquaculture as it is practiced today was introduced to most of Africa in the 1950's, as a rural smallholder subsistence activity to improve household nutrition and incomes. However, over time farming households demand for economic returns increased to meet their household objectives and mitigate against risks associated with agricultural productivity, impact of global markets and climatic change. At the macro-economic level, demographic changes and declining fishery yields compelled Member States to develop the sector in order to address national food and nutritional security challenges, employment, livelihoods and develop rural communities. By 2014, the continent had resolved that jumpstarting the development of market-led sustainable commercial aquaculture as a feasible option for increasing fish supply to address the above sustainably. However, how could this be achieved rapidly across the continent?

Upon consulting the continent's stakeholders, the approach taken was to develop a roadmap the prioritized establishing an enabling environment, improving service delivery, capacity building, trans-boundary ecosystem management for aquaculture and innovation. This reviews the continental performance and impacts the African Union's Aquaculture Action Plan 2016-2025 for aquaculture development in Africa.

TRANS-BOUNDARY ECOSYSTEM MANAGEMENT FOR AQUACULTURE: BIOSECURITY CONTROL

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Following the recommendations of the *Abuja Declaration on Sustainable Fisheries and Aquaculture in Africa* (2005), Africa's Policy Framework and Reform Strategy for Fisheries and Aquaculture in Africa (PFRS) adopts the FAO Code of Conduct for Responsible Fisheries, and leans on WTO's sanitary and phytosanitary measures as the most pragmatic and viable approach for achieving this, all-inclusively across the continent. Bearing in mind the transboundary nature of Africa's aquatic ecosystem, the African Union Aquaculture Action Plan 2016-2025 consequently outlines the establishment regional approaches for aquatic animal health management and biosecurity control.

The key accomplishments to-date include the launching of two Regional Aquatic Animal Health Networks (RAAHN) and a continental Regional Aquatic Animal Health Laboratory Network for Africa (RAAHLN-*Af*) in collaboration with the World Organization of Animal Health (WOAH). Africa's Aquaculture Action Plan recommended this approach in order to facilitate and strengthen continental capacity for implementing WTO's Aquatic Code and Codex Alimentarius in an all-inclusive manner that equally engages and benefits communities, smallholders, women and youth. The collective outcomes of led to continental decisions on the need to establishing continental strategies for aquatic animal health, biosecurity and vaccines to promote continental coherence in approach and the inclusion of Africa' aquatic animal health and biosecurity control concerns into the African Union's Comprehensive African Agricultural Development Programme (CAADP) Framework and Strategy 2025 - 2035 to consolidate outcomes to achieve long-term sustainable impact.

EMERGING TECHNOLOGIES IN AQUACULTURE: A SYSTEMATIC REVIEW OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING APPLICATIONS IN CAGE-BASED TILAPIA

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Background
The aquaculture as a whole and cage-based tilapia industry, particularly in tropical regions, face persistent environmental variability, disease outbreaks, and inefficient resource utilization challenges. AI and ML are being used in aquaculture to predict water quality changes, detect disease outbreaks early, and optimize feeding through real-time data analysis. By analyzing sensor and image data, water conditions, and disease symptoms are identified, and precise feeding decision automation is possible, thereby reducing waste, improving fish health, and enhancing resilience to environmental.

This paper systematically reviews Artificial Intelligence (AI) and Machine Learning (ML) applications in cage-based tilapia farming, aiming to explore how these technologies can enhance decision-making, predict critical parameters, and optimize production outcomes. Through an in-depth analysis of scholarly literature, the study identifies key AI/ML models used in water quality monitoring, growth prediction, feed optimization, and disease diagnostics. It also highlights gaps in data, infrastructure, local capacity, and model adaptability that hinder broader adoption in low- and middle-income countries.

Findings
A structured search across five academic databases yielded 2,064 articles on ML/AI in aquaculture, with only 213 focusing on tropical cage-based tilapia systems. Scopus alone returned 150 broadly relevant studies, narrowing to just 3 when filtered specifically for tropical tilapia cage farming. This highlights a scarcity of targeted research and exposes key gaps, such as limited access to high-resolution, location-specific environmental and production data; inadequate infrastructure like real-time water quality sensors and internet connectivity in remote farming areas, necessary to implement AI/ML tools effectively in tropical aquaculture contexts.

Conclusions
The findings underscore the transformative potential of AI and ML in improving productivity, sustainability, and resilience of aquaculture systems, while highlighting the need for integrated research, capacity-building, and policy frameworks to support responsible tech-driven innovation in tropical aquaculture.

THE EFFECT OF ALPHA-CYPERMETHRIN RESIDUES FROM COW MANURE ON POND FERTILIZATION, WATER QUALITY AND GROWTH PERFORMANCE OF NILE TILAPIA *Oreochromis niloticus*

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An investigative study was conducted to evaluate the effects of alpha-cypermethrin residues in cow manure used for pond fertilization on water quality, growth performance, and survival rate of Nile tilapia *(Oreochromis niloticus)*. Cow manure samples were collected from livestock farms in Kilosa District, Tanzania, and transported in a cool box to the Chief Government Chemist Laboratory Agency (CGCLA) in Dar es Salaam for chemical residue analysis.

Chemical analysis revealed that the samples contained alpha-cypermethrin at concentrations ranging from 0.39 to 52 mg/kg. A pilot study to determine the lethal concentration (LC_{50}) showed that 50% mortality of Nile tilapia fingerlings (average weight 0.5 ± 0.01 g) occurred at 416 mg/kg after 12 hours of exposure, increasing to 90% by 96 hours. Based on these findings and the residue levels observed in the field, sub-lethal concentrations of 0.4, 0.8, and 1.6 mg/kg were selected for the main experiment to simulate environmentally relevant chronic exposure.

The experimental setup involved twelve 100 L glass tanks, each lined with a 3 cm layer of loam soil and filled with 80 L of water. Tanks were stabilized for 10 days before stocking with Nile tilapia fingerlings (average weight 0.608 g) at a density of 20 fish per tank. Fish were acclimated for 5 days before the experiment began. Cow manure either unspiked (control) or spiked with alpha-cypermethrin was applied every 10 days at a rate of 260 g/m^3.

Survival rates were unaffected ($p > 0.05$), averaging 95% across all groups, consistent with expected natural mortality. However, significant reductions ($p < 0.05$) were observed in growth performance indicators such as weight gain, specific growth rate, condition factor, and hepatosomatic index in fish exposed to alpha-cypermethrin. Water quality analyses showed significant decreases in dissolved oxygen and pH ($p < 0.05$), while ammonia levels remained unaffected ($p > 0.05$).

These findings suggest that alpha-cypermethrin residues in cow manure, even at environmentally relevant levels, negatively impact water quality and the growth performance of Nile tilapia. The study underscores the need for educating fish farmers on the risks of pesticide contamination and promoting proper manure handling to protect fish health, ensure food safety, and improve aquaculture sustainability.

THE STRUCTURAL VARIATION LANDSCAPE IN THE EUROPEAN SEABASS (*Dicentrarchus labrax*) GENOME AND ITS POTENTIAL ROLE IN DISEASE RESISTANCE

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Structural variants (SVs) are typically defined as genetic polymorphisms that affect >50bp of sequence, including deletions, insertions, inversions, duplications, and translocations. While SVs are an important source of genetic variation and an important cause of inter-individual differences, they have been neglected in genetics studies compared with SNPs. Here, we defined the SV landscape in European seabass (*Dicentrarchus labrax*), a high value European aquaculture species. We used whole genome sequencing (WGS) in 90 animals to identify 21,428 high-confidence SVs using an established pipeline, with rigorous filtering and manual curation of every SV. These SVs were annotated to estimate potential effects on genes. Integrating SVs and SNP data generated previously, we imputed the SVs for 990 fish with phenotype data for viral nervous necrosis (VNN), one of the main infectious diseases in European seabass, allowing a GWAS analysis using the SVs. In GWAS, 108 (BS, binary survival) and 122 (DD, days to death) SVs exceeded genome-wide significance in a single QTL region matching previous work based on SNPs. The results will improve our understanding of the role of SVs in genetic architecture of traits relevant to aquaculture.

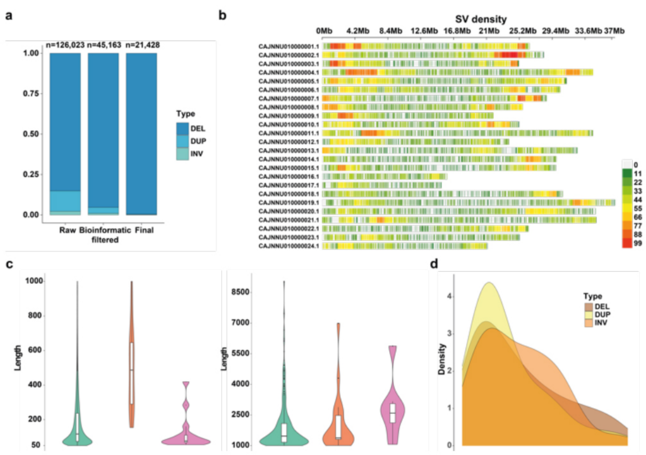

Figure 1. Landscape of SVs detected in the European Seabass. **a.** Illustration of SV counts before and after various filtering steps. **b.** SV density along different chromosomes (window size 1Mb). **c.** Violin plot for deletions (blue), duplications (orange), and inversions (pink), split into two length ranges: 50 to 1,000bp and 1,000 to 10,000 bp. **d.** SV minor allele frequency plot.

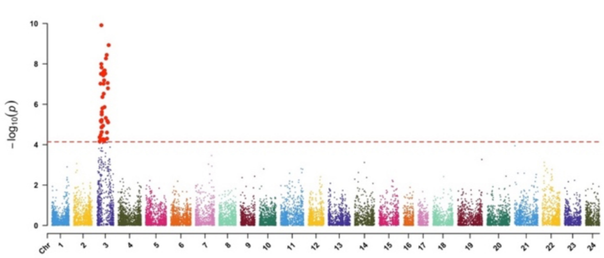

Figure 2. Manhattan plot about the GWAS with GCTA software for the trait of disease resistance. The values on the y-axis represent the −log10 of the P value and the x-axis the positions on the chromosomes. The red line is the 5% chromosome-wide significance threshold (Bonferroni correction) based on binary survival data.

DIFFERENCES IN SENSORY CHARACTERISTICS, CHEMICAL COMPOSITION AND PHYSICAL PROPERTIES OF FARMED AND WILD CAUGHT TILIPIA AND THEIR EFFECT ON SHELF LIFE

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Nile tilapia (*Oreochromis niloticus*) is an important economic freshwater fish species in Uganda. The intensive farming of Nile tilapia as well as the decline of wild caught tilapia has made farmed tilapia more available to consumers and mainstream seafood markets. This study aimed to evaluate the sensory characteristics, shelf life and chemical composition of farmed tilapia as compared to wild caught tilapia and to study if QIM schemes available in literature for tilapia, captured in particular, can as well be applicable to farmed tilapia. There was a significant difference ($P=0.01$) in fat content with 2.36±0.44g/100g of muscle for farmed tilapia and 1.14±0.42g/100g of muscle for wild caught tilapia. The difference in water content was significant for farmed and wild caught tilapia ($p<0.05$). The water content for farmed was 77.65±0.43% and 79.47±1.02% for wild caught tilapia. Higher Quality index QI score values were recorded in wild caught than in farmed tilapia throughout the storage time. A high correlation of $R^2 =0.829$ between QI and storage time for wild and $R^2 =0.726$ for farmed was recorded. On GDA, positive odour and flavour attributes were higher in farmed than wild caught. The negative odour and flavour attributes were more prominent in wild caught than farmed tilapia. The QI scores increased differently with storage time but showed a linear relationship for both groups. This indicates that the revised QIM scheme is applicable to both farmed and wild caught tilapia.

COMPARATIVE TRANSCRIPTOMIC ANALYSIS OF GILL, LIVER, AND MUSCLE TISSUES IN LARGE AND SMALL DUSKY KOB *Argyrosomus japonicus*

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Understanding the molecular mechanisms underlying growth differences in dusky kob (*Argyrosomus japonicus*), a commercially important finfish, is crucial for improving aquaculture. The gill enables gas exchange and osmoregulation, influencing metabolic efficiency and stress resilience. The liver serves as a metabolic hub, integrating nutrient processing, hormonal signals, and energy allocation. White muscle is the primary site of somatic growth, reflecting shifts in protein turnover and structural remodelling. Combined analysis of these tissues enables a systems-level understanding of growth variation.

This study analysed gene expression profiles from the gill, liver, and white muscle tissues of large (±550 g) and small (±250 g) dusky kob (*Argyrosomus japonicus*) of the same age and spawning event. Transcriptomic data was used to assemble organ-specific de novo transcriptomes and to identify differences in the expression of growth-related genes, as well as Gene Ontology (GO) term enrichment, between phenotypically large and small individuals using the DESeq2 (v1.42.1) and the clusterProfiler R package (v4.0.2).

A total of 7, 1312, and 87 differentially expressed genes (DEGs) in the gill, liver, and muscle, respectively, were functionally annotated (Table 1). In the gills, enrichment was observed in the small cohort for receptor-mediated signalling, likely reflecting stress or compensatory growth. In the muscle, enrichment was also detected exclusively in the small cohort, associated with cytoskeletal functions, suggesting tissue repair or adaptation to mechanical stress. In the liver, the large cohort showed enrichment for growth-associated signalling and tissue remodelling, consistent with accelerated growth and higher physiological demand, while the small cohort exhibited enrichment for proteolysis regulation, possibly reflecting metabolic strain or stress-related pressure.

Future analyses will incorporate weighted gene co-expression network analysis, variant detection, proteomics, and DNA methylation to enable an integrative multi-omics approach. This systems-level framework will offer deeper insights into the molecular architecture of growth variation in dusky kob, providing knowledge to optimize aquaculture through targeted genetic and environmental strategies.

Table 1. Distribution of differentially expressed genes (DEGs) by tissue and size group (FDR < 0.05)

Tissue	Total DEGs	Distribution of DEGs	
		Large	Small
Gill	7	4	3
Liver	1312	1252	60
Muscle	87	0	87

AU-IBAR CENTRES OF EXCELLENCE SHAPING THE DEVELOPMENT AND SUSTAINABILITY OF AFRICAN FISHERIES AND AQUACULTURE

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Despite Africa's vast aquatic resource endowment, its fisheries and the aquaculture sectors are performing substantially below their productive potential due to human resource and institutional capacity constraints. The creation of the African Union *Centres of Excellence (CoE)* to serve the fisheries and aquaculture sectors, under the auspices of the African Union Inter-African for Animal Resources (AU-IBAR), is arguably a timeous visionary strategy to address the capacity requirements for Africa to transform its fish production output to sustainably meet its food security requirements and develop its 'blue economy'. Various analyses highlight deficiencies in human resource capacity as a primary constraining factor in the achievement of sustainable fisheries management and aquaculture development. Due to Africa's rapid population growth, the continent is facing a 'demographic wave' of young people entering the workplace. This phenomenon presents numerous opportunities for aquaculture and fisheries. With the necessary investment in education, training and institutional capacity, this generation of human resources could reshape activities and practices in aquaculture and fisheries to increase per capita productivity and the gross domestic product (GDP). The network of African Union CoEs will provide the essential educational foundation for human resource capacity development through specialist knowledge required for a transformed aquaculture and fisheries output to meet food security requirements and develop the blue economy.

Thus far, the experience of the COEs shows that this is indeed possible. For this to ensue efficiently the current CoE capacities and its respective curricula needs to be aligned with the development needs of the fisheries and aquaculture sector. That is, CoE institutions must be 'fit for purpose' to deliver on this mandate for the African Union and member states. Historically, the CoEs were inaugurated and expanded to respond, as a whole, to the aquaculture and fisheries requests of the AU-IBAR. However, the CoE staff were simultaneously committed to full-time teaching and research responsibilities at the university, with extremely limited additional capacity. As such, their ability to serve AU-IBAR needs was limited and remains so.

To fully achieve the impact that CoEs could now have on the aquaculture and fisheries sectors in Africa, their capacity must be reviewed. The following suggestions should be taken into consideration:

- Establish *Education/Research Chairs,* based at a selection of the CoEs, to focus 100% of their efforts on the mandate of all the AU-IBAR's CoEs;
- Provide access to funding for (i) more postdoctoral fellows who are researchers, (ii) teaching development, and (iii) curriculum design expertise for them at the start of their careers so that they can provide the additional capacity at the CoE to seamlessly deliver on the mandate of the AU-IBAR and mobilise these young academics across the continent;
- Increase funding for collaboration in research and teaching across the continent for current and authentic development of foundational, practical, and reflexive competencies of students, researchers, and teachers from the different CoEs;
- Increase the number of bursaries for MSc and PhD to sustain the succession reservoir of experts and link the bursary opportunity to the collaboration activities above.
- Develop and implement a marketing and recruitment strategy aimed at school-going youth who are the next generation of stakeholders in aquaculture and fisheries sustainability.

This presentation will take the form of a participatory dialogue to further refine this conceptual framework for the CoEs shaping the development and sustainability of African aquaculture and fisheries to transform its fish production output to sustainably meet its food security requirements and develop its 'blue economy'. The discussion points that emerge in the dialogue will be provided to the AU-IBAR.

THE EFFECT OF REPLACING FISHMEAL WITH DEFATTED BLACK SOLDIER FLY LARVAE AND SOY PROTEIN MEALS ON GROWTH, PHYSIOLOGICAL AND BIOCHEMICAL PARAMETERS, AND IMMUNE GENE EXPRESSION IN AFRICAN CATFISH (*Clarias gariepinus*)

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A 12-week trial assessed replacing fishmeal (FM) with defatted black soldier fly larvae (BSFL) and soy protein (SOY) in African catfish *Clarias gariepinus* diets. Six hundred juveniles were fed five diets: control (100% FM) and 25%, 50%, 75%, and 100% FM replacement with BSFL and SOY (triplicates).

Fish fed 25% replacement showed growth similar to control, while 75% and 100% replacements reduced growth (Figure 1). Feed efficiency was highest at 25% and 50% replacement. Key physiological and biochemical markers, including hepatosomatic index, plasma alanine aminotransferase, IgM, total iron-binding capacity, and cortisol, varied significantly with diet (Table 1). The 50% replacement diet had the highest IgM; cortisol and iron-binding capacity increased at higher replacements.

Immune and growth gene expression was influenced by BSFL and SOY, with 50% replacement upregulating IGF-I and IgD, and 100% replacement increasing pro-inflammatory IFN-γ.

Defatted BSFL and SOY can replace up to 50% of fishmeal without harming growth or health, supporting their use as sustainable fishmeal alternatives.

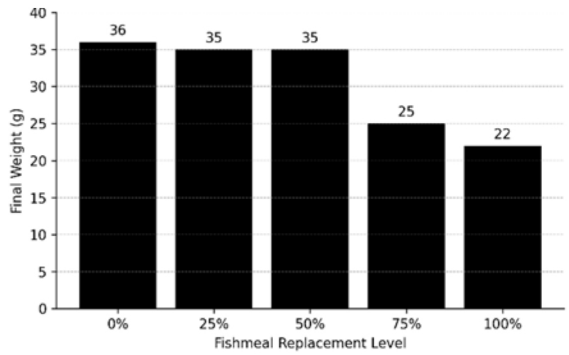

Figure 1. Final weight (g) of African catfish fed diets with varying fishmeal replacement levels.

TABLE 1. Selected physiological and biochemical parameters of African catfish after 12 weeks of feeding.

Parameter	**Control (0%)**	**25%**	**50%**	**75%**	**100%**
Hepatosomatic Index (%)	1.2 ± 0.1	1.3 ± 0.1	1.4 ± 0.1	1.1 ± 0.1	1.0 ± 0.1
Plasma ALT (U/L)	32 ± 3	30 ± 2	28 ± 3	40 ± 4*	45 ± 5*
Plasma IgM (mg/mL)	1.5 ± 0.2	1.7 ± 0.2	2.0 ± 0.3*	1.6 ± 0.2	1.4 ± 0.2
Total Iron-Binding Capacity (μmol/L)	45 ± 4	48 ± 3	52 ± 5*	55 ± 6*	58 ± 7*
Plasma Cortisol (ng/mL)	10 ± 1	12 ± 1	14 ± 2	18 ± 2*	22 ± 3*

Values marked with * are significantly different ($P < 0.05$) from the control group.

DIETS OF MORMYRIDAE (TELEOSTEI : OSTEOGLOSSIFORMES) IN TWO RIVERS OF CONGO BASIN (BOUMBA AND KADEI) IN EASTERN CAMEROON

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As part of a larger research program on the diversity and role of the forest in maintaining the local ichthyofauna of the Congo Basin, a study focused on the diets of Mormyridae, a family of many fishes represented in the Boumba and Kadei rivers in eastern Cameroon. Indeed know the diet of savage specie fish can help to make their conservation by aquaculture processes.

The collection of different fish samples took place monthly from December 2018 to May 2019 on the landing stages of Boumba and Kadei rivers independently of the fishing gear (dormant gillnets, cast nets, hooks and creels) used by the fishermen.

The Captured fish were identified using specific keys, then were labeled, photographed, measured (total and standard lengths), weighed and dissected in order to remove their stomachs and intestine which were preserved in tubes containing alcohol at 70%. These stomachs and intestine were then emptied separately and the contents rinsed in Petri dishes, then filtered through a sieve and the retained fractions were sorted, separated, identified, counted and weighed in order to evaluate the rate of food from the riparian forests.

A total of 22 specimens of Mormyridae, divided into seven genera and 10 species were collected at Boumba compared to a total of 87 specimens divided into 11 genera and 24 species at Kadei.

The qualitative analysis of stomach and intestine contents reveals that, independently of the seasons, the diet of Mormyridae of Boumba and Kadei oscillates around three food categories: macroinvertebrates, macrophytes, and other various particles; however the most represented food item in the diet of Mormyridae are macroinvertebrates, which still identifiable until the intestine level (see table 1).

Table 1: Presence-absence of prey identified in the intestine contents of dissected individuals.

		Foods items in the intestin						
		Macroinvertebrates					Others	
	Species	Co	Di	Le	BI	Det	VN	CB
Boumba	*Campylomormyrus tamadua*			+				
	Marcusenius mento		+					
Kadei	*Campylomormyrus* sp.1					+		
	Campylomormyrus sp.2					+		
	Cyphomyrus psittacus					+		+
	Marcusenius greshoffi					+		
	Marcusenius mento					+		
	Momyrops attenuatus	+				+		
	Mormyrops anguilloides						+	
	Mormyrus caballus					+		
	Mormyrus cashive					+		
	Mormyrus iriodes	+				+		
	Petrocephalus simus				+			

The Mormyridae are highly prized by the local population due to their taste and their fairly large body mass, thus depending on their strong preference for animal food origin, the Mormyridae have good aquaculture potential. This is for example the case of *C. tamadua* which has a good ability to exploit the different invertebrates present in its living environment; it can easily adapt to feeding by Diptera larvae in pond. It is also the case of *M. anguilloides* which due to its fish-eating predatory nature, could be tested in aquaculture to regulate the populations of very fertile and invasive species (*Oreochromis nilitucus* etc.) Furthermore, the success of these species in ponds must also take into account the physico-chemical parameters of the water suitable for the proper development of each of them.

However, the forest of the Congo Basin is home to numerous insects (macroinvertebrates) which are important source of food for the ichthyofauna of his different rivers. Consequently, deforestation would negatively impact certain taxa of fish such as the Mormyridae which depend on them and would inevitably lead to their loss.

OPPORTUNITIES FOR SMALLHOLDERS TO PRODUCE OWN FEED WITH BLACK SOLDIER FLY LARVAE *Hermetia illucens* A CASE STUDY IN UGANDA

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Aquaculture has become a major contributor to food and nutrition security and enhanced livelihoods in sub-Saharan Africa. However, one of the major challenges is the lack of a stable supply of affordable, accessible, high-quality, and protein-rich feed to enhance productivity. Particularly small-scale aquaculture farmers have limited access to such feed because commercial feed is highly priced accounting for approximately 70% of their production costs.

Insect-based feed ingredients such as Black Soldier Fly Larvae (BSFL) are low-cost, nutrient-rich alternatives with the potential to become easily accessible to smallholders. BSFL are rich in protein and lipids and have an excellent amino acid profile making them a suitable and affordable option as aquaculture feed. They are more sustainable fish feed compared to soya and fishmeal with significantly lower carbon footprint. Also, BSFL generates a valuable byproduct i.e. frass which is a high-quality fertiliser. BSFL can be reared with relatively simple and low-cost methods, making it accessible, particularly for small-scale farmers. Despite its great potential, BSFL-based fish feed is not yet widely adopted in sub-Saharan Africa. The reasons BSFL are not yet widely available or adopted by a large number of smallholders, and whether specific contextual conditions are required for extensive uptake, remain unclear.

This study aims to explore the BSFL's role as a regularly used component of fish feed among smallholders in Uganda. It seeks to identify key bottlenecks and opportunities for increased adoption to prepare for increased involvement in production of BSFL.

The methods include a literature review and in-depth interviews. The preliminary results can be summarised as shown in Figure 1.

This will be followed by a questionnaire survey, small-scale farmer workshops, and the final results will be presented in a dissemination workshop in October 2025.

Relevant main challenges can be categorised into increase of cultural, institutional, market, knowledge and production opportunities. These categories are further subdivided into specific sub-categories and will be validated by extensive interactions with and among smallholders.

This research is financed by the Federal Republic of Germany, represented by the Federal Ministry for Economic Cooperation and Development (BMZ).

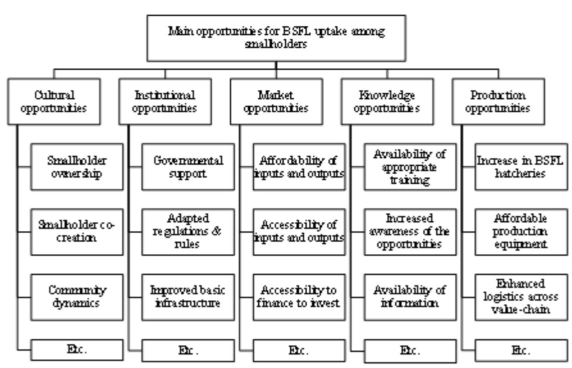

Figure 1. Relevant opportunities enhancing uptake of BSFL among smallholders.

FISH PROBIOTIC APPLICATIONS: INCREASE IN HETEROTROPH BACTERIAL POPULATIONS AND DECREASE IN PATHOGENIC BACTERIA IN POND AND STOMACH WATER SAMPLES OF CATFISH (CLARIAS GARIEPINUS)

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Probiotics are live microorganisms that are beneficial to their hosts, one of which is fish. Probiotics are dietary supplements in the form of microbial cells for fish that can inhibit the growth of pathogenic microorganism populations. The administration of probiotics can help maintain the quality of pond water in fish farming, prevent, and overcome fish disease attacks because it can inhibit the growth of pathogenic bacteria such as Aeromonas bacteria, and improve feed efficiency. Fish growth is influenced by the work of the digestive tract in absorbing nutrients, this is due to the help of the activity of enzymes amylase, protease, lipase, and cellulase (Warman, 2020). The problem of feed efficiency in the world of fisheries is that the price of feed basic materials is getting higher and difficult to obtain. This general problem is also felt by the Association of Farmer/Pond Groups (GAPOKTAN) in several regions in Indonesia. Muntafiah (2020) stated that the high price of feed comes from the use of factory feed raw materials which are imported commodities, causing large costs for fish farmers. Quality feed has complete nutritional content, is easy for fish to digest, and does not contain substances that are harmful to fish. Adinugroho et al. (2014) state that feed can meet the energy needs for fish to live and grow. The quality of feed can affect the use of feed by fish, both in terms of nutritional content and the level of digestibility of feed so that it can reduce ingredients that cannot be digested properly. Iribarren et al. (2012) stated that the use of probiotics is an internal solution to produce optimal feed growth and efficiency, reduce production costs, and ultimately reduce environmental burden due to waste accumulation in waters.

SEAWEED BEST MANAGEMENT PRACTICES IN SOUTH COAST, KENYA

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Seaweed farming is a widely practiced and promising livelihood activity in many tropical coastal regions, including East Africa and the Western Indian Ocean (WIO). Compared to other forms of aquaculture, it has minimal environmental impact and can be made even better through employment of best management practices. The study was done through conducting of in-class and on the job training and feedback google questionnaire survey at the end of the training. The training course (in class and on the job training) on Seaweed Best Management Practices (BMP) was conducted for two key farming villages (Bati-Mwazaro and Kibuyuni) in the south coast of Kenya, to enable the farmers with the goal of promoting sustainable seaweed farming techniques and adopt new farming methodologies that are compliant with the environment and will increase production.

The training workshop brought together key stakeholders, including farmers (61 %), researchers (6.6%), trades ((16%) and environmentalists (16.4%), to address the best management practices and discuss the benefits of sustainable practices in seaweed cultivation. Participants engaged in practical sessions, gaining hands-on experience in optimal farming techniques, environmental sustainability, and market opportunities. The study realized a number of results in a seven-day training session that included. Training of farmers (23%of males and77 % of females), Training of 16 training of trainers (6% males, 10% females-Mwazaro)/ (8% males,8%), establishment of four demonstration plots i.e. 200 lines (each plot has 50 lines), seaweed farming calendar developed, and participatory mapping of seaweed farms in the villages.

Participant feedback at the end of the training indicated a strong commitment to applying the knowledge gained (92%), fostering a collaborative (95 %) and the significance of the training to address sustainable approach to seaweed farming in the region. Overall, it was evident that combination of class and practical training for farmers could provide more gains for the farmers than any one method done independently.

ASSESSMENT OF THE VARIABLES AFFECTING FISH MARKETING IN LODWAR FISH MARKET, TURKANA

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Fisheries contribute more 0.5% of the country's DDP. This fish value chain provides direct employment from the fisher, distributor, and processors up to the point it gets to the consume. Apart from providing employment, fish can help promote food security by making more nutritious food available at an affordable cost. Since fish products are highly perishable marketing is an invaluable component in the fish venture. Although the fish market plays a vital role in the fish value chain in Lodwar, their operation is facing various challenges that limit operation and consequently affecting distribution of fish and fish products. The study aimed at identifying different marketing methods used in Lodwar fish market, factors affecting marketing and to identify possible mitigation measures to these challenges.

A total of 40 respondents participated in the study, including one officer from the Kenya Marine and Fisheries Research Institute (KMFRI), two officers from the State Department, five fish sellers, twenty members of the fishing community, two fish brokers, and ten fish customers. Purposive sampling was used to select the KMFRI and State Department officers, while simple random sampling was employed for the remaining participants. Data was collected through semi-structured questionnaires using a survey research design.

The data were analyzed using descriptive statistics with the aid of Microsoft Excel 2016 and presented in the form of pie charts and bar graphs. The findings revealed that while fish marketing was an essential income-generating activity in Lodwar, it was hindered by inadequate infrastructure, limited access to market information, and poor handling practices. The study highlighted the need for targeted interventions to improve market efficiency, enhance income for stakeholders, and ensure the sustainability of the fish value chain.

THE STATUS OF AQUATIC VETERINARY SERVICES IN THE REGION: OPINIONS OF FARMERS, SECTOR AND VETERINARY PRACTITIONERS - THE CASE OF UGANDA

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Aquatic veterinarians are essential in the investigation and treatment of diseases, epidemiological enquiries, nutrition, feeding and welfare of aquatic animals. Recent reports indicate new emerging important diseases in both farmed and wild fish populations. Nevertheless, few veterinarians have taken on aquaculture veterinary practice in Uganda. It is not clear why few veterinarians are practicing in aquaculture in Uganda. The goal of this study was therefore to assess the factors influencing veterinary service delivery in aquaculture in Wakiso and Mpigi districts in Uganda. The study involved practicing veterinarians, veterinary students and fish farmers.

A cross-sectional study was undertaken to examine factors affecting aquatic veterinary service delivery in aquaculture in Wakiso and Mpigi districts Uganda. Primary data was collected using a semi-structured questionnaire administered to 242 purposively selected 92 veterinary clinical year student, 90 field veterinarians and 60 fish farmers in the two districts in Uganda. Descriptive statistics mainly percentages and frequencies were computed to identify key characteristics of farmers and extension officers. Analyses were done using SPSS Version 26.0.

The results indicated that the academic curriculum, interest of veterinarians and aquaculture policies were the major factors reported to affect veterinary service delivery in aquaculture in the two districts in Uganda. Improving academic curriculum and establishing continued veterinary professional training programs in aquatic medicine, farmer sensitization and aquaculture policies in Uganda was likely to boost veterinary service delivery in aquaculture in Uganda.

POTENTIAL EFFECTS OF 17-ALPHA-METHYLTESTOSTERONE USED IN ALL-MALE PRODUCTION OF *Oreochromis niloticus* ON S*clerophrys regularis* INHABITING PONDS USED FOR SEX REVERSAL

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Nile tilapia is among the various fish species reared in cages, pens, and ponds. However, the major drawback of tilapia pond culture is the high level of uncontrolled breeding that occurs in grow-out ponds. This results in the population surge of stocked tilapia ponds and leads to stunted growth because of the crowding of the fish. Among other techniques that have been used to control tilapia overpopulation is the use of monosex all-male tilapia culture. Hormone 17-alpha-methyltestosterone is commonly used in the sex reversal of Nile tilapia. However, it is not clear how these hormones interact with other organisms in the ponds. The study aimed to assess the potential effects of 17-alpha-methyltestosterone on the growth of the tadpoles bred in the same pond.

Tadpoles were divided into two groups; the control and the exposed group. The exposed group fed on feeds having 17-alpha-methyltestosterone while the control fed on hormone-free feeds for 28 days. The weights of tadpoles were taken on days 0,18 and 28 of exposure. Descriptive statistics was used to obtain the mean and standard error means of the variables in the two groups. Independent sample t-tests were used to compare the two groups at a 5% level of significance.

It was observed that 17-alpha-methyltestosterone had effects on the size and weight of the toadlets. The low variability observed in exposed population suggests tadpole in the hormone exposed group underwent sex reversal. We suggest 17-α-methyltestosterone hormone can potentially affect the toad populations in the environment where Nile tilapia sex reversal is conducted using hormones.

MOBILE FISH PROCESSING PLANT FOR ONSITE FISH HARVESTING AND PROCESSING

The Big Three Aquaculture Experts

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This innovation introduces a mobile fish processing plant designed for onsite fish harvesting and processing. The plant consists of a 6mx4m tented processing room equipped with detachable tented water sinks with detachable water pipes and tapes, a detachable tented 1000 litres water tank on detachable stand, portable detachable stainless steel processing tables with water pipes, tapes and bleeding bowls.

The plant utilizes a bilge pump to draw water from the source into the water tank, which water is then chlorinated before it is used in the processing plant. The design features detachable components, including poles, tables, tank stands and water pipes, allowing for easy transportation and set up.

The mobile fish processing plant can be carried by a small truck and set up onsite, reducing transportation costs and preserving fish quality. The plant's tented design and cooling systems, including shade net vents and kaylite roofing, provide a suitable environment for fish processing.

This innovation has the potential to improve fish processing efficiency, reduce post-harvest losses, and enhance food safety in remote or underserved fishing communities.

Key Features
• Mobile and portable design
• Onsite fish processing and harvesting
• Detachable components for easy transportation and set up
• Chlorinated water systems for improved food safety
• Cooling systems for temperature controls

Potential Applications
• Remote or underserved fishing communities
• Small scale fisheries
• Emergency response situations
• Temporary fish processing needs

ASSESSMENT OF THE SENSITIVITY PATTERNS OF SELECTED MICROORGANISMS ISOLATED FROM THE CROCODILE POND WATER AT UGANDA CROCS LIMITED, BUWAMA

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In veterinary medicine as well as human medicine, antimicrobial resistance has been identified as a growing global issue. The antimicrobial agents used are thought to be the most important factor in the emergence, selection, and spread of antibiotic-resistant bacteria. The overall objective of this study was to determine the sensitivity patterns of selected microorganisms isolated from the crocodile pond water at Uganda Crocs limited, Buwama, Mpigi District. A total of 23 water samples were collected in August 2022. These samples were cultured for *Escherichia coli*, *Salmonella* sp. and *Staphylococcus aureus*, after which biochemical tests were carried out to confirm the species. Biochemicals tests for confirmation of *E. coli* included; hydrogen sulphide gas production (negative), indole (positive), motility (positive), methylene red (positive), citrate (negative) and urease (negative) and those for confirmation of *Salmonella sp.* included; hydrogen sulphide gas (positive), indole (negative), motility (positive), methylene red (positive), urease (negative) and citrate (negative). Out of the 23 samples; 16 samples tested positive for *Salmonella sp* and 13 samples for *E. coli*. No sample tested positive for *Staphylococcus aureus*. Antimicrobial susceptibility tests on Mueller-Hinton agar were performed on all the 29 confirmed isolates using various antimicrobial agents: Ciprofloxacin, Ceftriaxone, Ampicillin, Tetracycline, Sulphamethoxazole and Gentamicin. All *E. coli* isolates showed no resistance to Gentamicin and Ceftriaxone, whereas, all *Salmonella sp.* isolates showed no resistance to Gentamicin, Ciprofloxacin, Tetracycline and Ceftriaxone. There was varying resistance to Ciprofloxacin (38.5%), Ampicillin (92.3%), Sulphamethoxazole (84.6%) and Tetracycline (84.6%) for *E. coli* isolates, and varying resistance to Ampicillin (75%) and Sulphamethoxazole (6.3%) for *Salmonella sp.* Additionally, all the 16 *Salmonella sp.* isolates were 100% susceptible to Gentamicin, Tetracycline and Ceftriaxone, with varying susceptibility to Ciprofloxacin (75%), Ampicillin (6.3%) and Sulphamethoxazole (93.8%). This investigation revealed that *E. coli* had higher rates of resistance to drug classes critical to human and animal health than *Salmonella sp.* According to some theories, this resistance may be the result of the selection pressure from recent drug exposure, through mutation, or through particular resistant gene transfer.

ENHANCING MARKET ACCESS AND ECONOMIC GROWTH THROUGH NATIONAL AQUACULTURE FOOD SAFETY STANDARDS

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Aquaculture is among the fastest-growing food-producing sectors globally, offering vital sources of employment and livelihoods. The intensification of aquaculture has led to a compound annual growth rate of 15.55% on the continent. Despite producing over 100,000 metric tonnes, aquaculture still holds significant potential to help offset the decline in capture fisheries in Uganda. The sector contributes approximately 3% to the national GDP and supports the livelihoods of over 1.7 million people. Despite its significance, the aquaculture subsector faces numerous challenges, including low-quality feed and seed, disease outbreaks, inadequate extension services, post-harvest losses, weak marketing systems, and the absence of food safety guidelines. For aquaculture to achieve sustainable growth and deliver economic benefits, clearly defined food safety standards are essential. The lack of an official aquaculture food safety guideline significantly limits the marketability and competitiveness of aquaculture products.

Aquaculture products are currently marketed despite issues such as pests, diseases, and antibiotic residues originating from feed and the environment. In the absence of clearly defined protocols and guidelines to identify and address these challenges, aquaculture products are unable to access high-value markets like the EU and Middle East, resulting in diminished economic returns for the sector.This study highlights the critical need to establish national aquaculture food safety guidelines in order to broaden market access and boost revenue from aquaculture products.

GLOBAL MARKET TRENDS AND INVESTMENT OPPORTUNITIES IN ARTEMIA AQUABUSINESS

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As aquaculture expands and the global demand for sustainable feed ingredients intensifies, Artemia (brine shrimp) is re-emerging as a strategic asset across the aquatic food value chain. This abstract synthesizes recent findings from a global investment-focused study funded by the World Bank and PROBLUE, highlighting Artemia's untapped potential in both traditional and novel markets.

Artemia offers a promising and underused alternative to fishmeal and soy, especially in regions like Africa and Asia that face saline land constraints and rely heavily on imported feed ingredients. Artemia offers a high-protein, digestible feed solution that is compatible with circular, climate-smart agricultural models. Beyond feed, its use in human nutrition is gaining traction, with applications in fortified foods, snacks, and alternative protein products, particularly in climate-vulnerable and food-insecure regions.

The study presents diverse business models from China, Vietnam, Thailand, and Bangladesh, demonstrating scalable Artemia farming systems integrated with solar salt operations or aquaculture. Profit margins range from 30% to 90%, depending on the level of processing, vertical integration, and market orientation. Investment viability is strengthened by Artemia's alignment with blue economy objectives, land rehabilitation, and gender-inclusive employment opportunities.

However, the sector's growth is constrained by biosecurity risks, policy gaps, certification challenges, and exposure to environmental shocks. Addressing these barriers requires coordinated action across governance, technology, and finance.

To catalyze scale, a three-pronged investment roadmap is proposed: (1) integrated Artemia-salt-aquaculture systems, (2) biomass-to-feed innovation hubs, and (3) nutrition-sensitive Artemia food models. These entry points are supported by cross-cutting enablers including blended finance, stakeholder platforms, regulatory anchoring, and gender-responsive approaches.

This presentation will share strategic insights into emerging markets, profitability benchmarks, and scaling conditions, positioning Artemia not only as a technical solution but as a transformative investment opportunity for sustainable aquaculture, food security, and coastal livelihoods.

THE CONTRIBUTION OF GHENT UNIVERSITY EDUCATION: PERSPECTIVES FROM PROFESSIONALS IN TANZANIA'S AQUACULTURE SECTOR

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Being 2012 MSc. Aquaculture graduate from Ghent university solidified my aquaculture professional skills after obtaining my BSc. Aquaculture in 2007 from Sokoine University of Agriculture in Tanzania. Ghent University not only improved my skills but also created confidence, regional and international collaborations that contributed to the significant contributions I have made in the development of Aquaculture in my country which has grown >300% in the past 15 years. I have been trusted to serve higher posts such as Assistant Director of Aquaculture in Tanzania and currently serving regionally as Lake Tanganyika Aquaculture Specialist under The Nature Conservancy.

Ghent University being ***Artemia Reference Canter – ARC***, immensely contributed to my championship in leading Artemia research project in the country known as *Optimizing Artemia Production Technology for Sustainable Aquaculture Development (APTSAD) For Food Security and Economic Growth for East African Coastal Communities* funded by WIOMSA. Achievements obtained include the awareness created to the public and policy makers on the significancy of Artemia in Aquaculture Industry. Accordingly, capacity building to the coastal community through practical training on Artemia farming, Artemia demonstration farms/ponds, and research sponsorship to a MSc student. Other achievement is the recent publication titled ***Biometry, hatching efficiency, growth performance and survival of the brine shrimp Artemia franciscana from Tanzania*** published in ***African Journal of Marine Science***, DOI: 10.2989/1814232X.2024.2443545.

Nevertheless, Aquaculture in Tanzania is still challenged by low productivity due to slow adoption of best management practices, low investments, poor technology, insufficient skills in writing bankable aquaculture projects/proposals, business management, partnership, market and ICT skills. Major focus of aquaculture courses has been on the fish production and leaving the business, marketing and value addition behind which are key aspects in commercial aquaculture. Therefore, capacity building is required for both aquaculture professionals and practitioners to be able to push aquaculture in higher dimension.

LAKE TANGAYIKA AQUACULTURE DEVELOPMENT, ADVANCING SUSTAINABLE AQUACULTURE

Dr. Imani Kapinga*, Fridolin Nzambimana, Lucy Mlagala, Jonathan MacKay, Tiffany Waters, Dr. Heidi Alleway, Colin Apse, and Taylor Voorhees

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Founded in 1951, The Nature Conservancy (TNC) has grown to become one of the most effective and wide-reaching environmental organizations in the world. Thanks to more than a million members and the dedicated efforts of our diverse staff with over 1,000 scientists globally, we impact conservation in 81 countries and territories. Looking towards the future, TNC's 2030 Goals aim to address the dual crises of climate change and biodiversity loss through three primary pathways: protecting oceans, lands, and freshwater; tackling climate change; and providing food and water sustainably.

Lake Tanganyika, an ancient rift lake in the East African Rift Valley, harbors an extraordinary ichthyofaunal diversity, with approximately 250 documented cichlid species, 98% of which are endemic. The lake serves as a natural water body for evolutionary biology, showcasing unparalleled adaptive radiation, where cichlids have diversified to exploit a broad spectrum of ecological niches, ranging from rocky littoral zones to sandy substrates and pelagic waters. The riparian community around Lake Tanganyika relies heavily on the freshwater resources for their livelihoods, serving as a main source of animal protein and contributing to about 60% of their protein source. However, fish production from the Lake has decreased by 18% in the past four years due to many factors including overharvesting of wild populations and climate change.

The current population of Lake Tanganyika is more than 12 million people and is growing at a rate of 2-3% per year. The most recent official annual catch estimates were less than 100,000 tons against 150,000 - 200,000 tons three decades ago. The rates of malnutrition in the Lake Tanganyika community are currently above 40% which are associated with increased risk of all-causes of mortality. Given the fast population growth and dwindling fish catches, aquaculture is expected to augment the growing deficit in fish supply and reduce the increasing rates of malnutrition among children aged 1-5 years.

As part of ongoing efforts with key stakeholders and building on past projects in the Lake Tanganyika basin, we aim to (1) work with the Lake Tanganyika Authority to ensure implementation of the newly created Protocol on Aquaculture Development; (2) build capacity through trainings with the Tanzania Fisheries Research Institute and to maintain and update siting tool; and (3) collaborate with the Government to ensure siting analyses are applied to incoming permit considerations. Through these efforts, TNC is committed to advancing sustainable aquaculture practices that benefit both the environment and local communities, contributing to our overarching goal of a sustainable and resilient future.

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STRENGTHENING ENVIRONMENTAL AND CLIMATE RESILIENCE INTO AQUACULTURE

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Environmental randomness and climate change effects pose significant threats to aquaculture. Climate change and environmental randomness or shocks whether positive or negative, are integral part of fisheries and aquaculture systems and impact those drivers that would affect the aquatic systems' biological processes through, changes in water quantity and quality, temperature, salinity, oxygen, acidity, fishing pressure and natural habitats, as well as drivers of change that impact human choices in their use of aquatic resources, such as changes in governance structures, input and output prices, technological change, emergencies and cultural aspects.

Aquaculture is mostly environmental fragile, climate sensitive and vulnerable. The impact of climate change on aquatic ecosystems include climate hazards, such as flooding, drought and affecting fishstocks, but these hazards are more likely to have a diminishing effect on food security because of a high reliance on fish and other aquatic foods. Environmental degradation and climate risks to aquatic food systems are often confronted by inadequate capacity that limits the technical capability and institutional ability to effectively manage the environment and enhance resiliency to adapt to climate related challenges.

Application of better practices including robust policies, tools, strategies and plans for aquaculture zoning mechanisms at the watershed level, biosecurity frameworks, risk analysis and strategic environmental assessments would take into consideration the added effects on aquaculture farms and would enable the sector to better face potential threats such as new diseases, invasive species and fish quality.

Failure to integrate climate change and environment into the aquaculture management system, the resulting effect of change may be highly negative on long-term sustainability that aquaculture would decline and collapse the sector. Climate change and environmental degradation would put pressure on aquaculture and the question of how to meet increasing demand for fish in the face of climate change and environmental degradation would pose great threats to aquaculture management.

HAEMATOLOGICAL PARAMETERS, GUT MORPHOLOGY, AND HISTOPATHOLOGICAL ASSESSMENT OF AFRICAN CATFISH (CLARIAS GARIEPINUS) FED A COMBINED COMMERCIAL DIET AND BLACK SOLDIER FLY LARVAE

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Aquaculture plays a vital role in global food security, with African catfish (*Clarias gariepinus*) being a key species in Africa. Despite industry growth, challenges in sustainable fish nutrition persist, as traditional feeds like fishmeal and soybean meal are costly and environmentally taxing. Black Soldier Fly (BSF) larvae offer a promising alternative, providing high protein content and eco-friendly benefits. However, their impact on haematological parameters, gut morphology, and histopathology in African catfish remains underexplored. Investigating these effects will enhance understanding of BSF larvae's role in optimising fish health and aquaculture sustainability.

The study was conducted at the UI-FAO greenhouse, University of Ibadan, using 105 juvenile African catfish (*Clarias gariepinus*). Fish were randomly assigned to five dietary treatments: (1) 100% commercial feed, (2) 40% live Black Soldier Fly (BSF) larvae + 60% commercial feed, (3) 80% live BSF larvae + 20% commercial feed, (4) 100% live BSF larvae, and (5) 100% formulated diet. The 10-week trial assessed haematological parameters, gut morphology, and histopathology. Blood and tissue samples were analysed to evaluate BSF larvae's impact on fish health, providing insights into sustainable aquaculture nutrition.

African catfish fed Black Soldier Fly larvae showed stable haematological health. Oxygen transport, immune response, and red blood cell indices remained consistent across treatments, with slight platelet and eosinophil variations suggesting immune modulation. No adverse effects observed. The fish fed Black Soldier Fly larvae exhibited varying gut morphology. The T1 and T5 had the highest villi height and width, enhancing absorption, while T2, T3, and T4 had lower values. Crypt depth varied, while muscle thickness differed, affecting intestinal integrity and digestion. Dietary treatments influenced African catfish organ health. Control diet showed no lesions, while Black Soldier Fly larvae diets caused kidney necrosis and liver swelling. Histopathological changes varied, highlighting diet-dependent effects on intestinal, hepatic, and renal tissues.

This study established that black Soldier Fly larvae diets influenced haematological stability, gut morphology, and organ health in African catfish, demonstrating potential for sustainable aquaculture nutrition while highlighting the need for optimised formulations to minimise histopathological alterations and enhance overall fish growth and physiological resilience.

Table 1: Haematological Changes in African Catfish (Clarias gariepinus) Fed a Combined Diet of Commercial Feed and Black Soldier Fly (Hermetia illucens) Larvae

TREATMENTS	T1	T2	T3	T4	T5
PVC (%)	40.00±3.56^{a}	43.00±2.45^{a}	43.33±9.39^{a}	40.67±6.13^{a}	40.33±5.56^{a}
HB (g/dl)	12.83±1.30^{a}	13.83±0.94^{a}	13.77±3.07^{a}	13.00±2.00^{a}	13.07±1.90^{a}
RBC (×10^{6}µL)	3.82±0.32^{a}	3.92±0.27^{a}	3.85±0.52^{a}	3.91±0.45^{a}	3.68±0.44^{a}
WBC (×10^{3}µL)	20916.67±10054.38^{a}	17666.67±4124.99^{a}	15733.33±4340.76^{a}	17816.67±1414.41^{a}	17433. 33±2595.29^{a}
MCV (Fl)	104.57±1.46^{a}	109.79±1.68^{a}	111.38±9.66^{a}	103.58±5.36^{a}	109.39±5.56^{a}
MCHC (Pg)	32.05±0.44^{a}	32.15±0.35^{a}	31.71±0.66^{a}	31.96±0.36^{a}	32.37±0.25^{a}
MCHC (%)	33.51±0.85^{a}	35.29±0.32^{a}	35.35±3.47^{a}	33.12±2.01^{a}	35.41±1.81^{a}
PLATELET (µL)	149333.33±19482.19^{a}	172000.00±17204.65^{a}	180000.00±18184.24^{a}	184000.00±27820.86^{a}	183333.33±23584.36^{a}
LYMPHOCYTES (%)	70.67±3.30^{a}	72.00±2.94^{a}	72.33±6.24^{a}	72.00±3.74^{a}	69.67±4.11^{a}
HETEROPHILS (%)	23.33±4.71^{a}	20.33±2.87^{a}	21.67±5.79^{a}	20.67±4.11^{a}	23.00±3.27^{a}
MANOPHILS (%)	3.33±0.47^{a}	2.67±0.94^{a}	1.67±1.25^{a}	3.33±0.47^{a}	3.33±0.47^{a}
EOSINOPHILS (%)	2.67±1.89^{a}	4.33±1.25^{a}	4.33±0.94^{a}	3.67±0.47^{a}	3.67±0.94^{a}
BASOPHILS (%)	0.00±0.00^{a}	0.67±0.47^{a}	0.00±0.00^{a}	0.33±0.47^{a}	0.33±0.47^{a}

NOTE: Values with different superscripts indicate significant differences while values with the same superscripts indicate no significant differences in the mean values among treatments. Values with different superscripts differ significantly ($p<0.05$) between concentrations within the same column. Abbreviations: PCV = packed cell volume, HB = Haemoglobin, RBC = Red blood cell, WBC = White blood cell, MCV = Mean cell volume, MCHC = Mean cell haemoglobin concentration, MCH = Mean cell haemoglobin

Table 2: Gut Morphological Adaptations in African Catfish (Clarias gariepinus) Fed a Combined Diet of Commercial Feed and Black Soldier Fly (Hermetia illucens) Larvae

TREATMENT	T1	T2	T3	T4	T5
Villi height (nm)	2042.69±19.61^{a}	1913.61±3.02^{b}	1950.82±29.37^{b}	1943.39±3.19^{b}	2043.40±34.27^{a}
Villi width (nm)	204.53±1.43^{a}	191.58±0.07^{b}	196.00±2.21^{b}	194.28±0.06^{b}	203.40±2.72^{a}
Cryptal depth (nm)	422.28±1.68^{a}	352.04±0.54^{b}	387.98±2.40^{d}	367.42±0.12^{c}	388.91±5.05^{d}
Cryptal width (nm)	202.48±0.45^{a}	192.03±0.92^{b}	192.16±0.46^{b}	194.18±0.47^{b}	204.26±2.70^{a}
Muscle thickness (nm)	247.27±5.38^{bc}	343.71±16.17^{a}	242.78±2.60^{bc}	218.38±1.44^{b}	260.14±17.17^{c}

NOTE: Values with different superscripts indicate significant differences while values with the same superscripts indicate no significant differences in the mean values among treatments. Values with different superscripts differ significantly ($p<0.05$) between concentrations within the same column.

COMPARATIVE ESTIMATION OF THE METHIONINE REQUIREMENTS FOR THE UNIMPROVED KAFUE STRAIN AND GENETICALLY IMPROVED STRAIN OF *Oreochromis andersonii* AT JUVENILE STAGE

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The aquaculture industry in Zambia is expanding rapidly, necessitating the development of cost-effective and nutritionally optimized feed. One major challenge is the lack of established nutrient requirements for indigenous species, particularly for essential amino acids such as methionine. Methionine is critical for growth and metabolic processes, but is often limiting in plant-based feed formulations.

This study aims to estimate and compare the methionine requirements of two key strains of *Oreochromis andersonii*—the domesticated Kafue strain and the genetically improved GIP strain at the juvenile stage. Conducted within a recirculating aquaculture system (RAS), the experiment used a 2×6 factorial design with six graded levels of dietary methionine (0.51%, 0.60%, 0.80%, 0.90%, 1.10%, and 1.30%) across both strains. Fish were fed formulated diets and monitored over a 12-week period, with growth performance, feed intake, and survival rates recorded.

Baseline and end-point analyses were conducted to evaluate nutrient retention and amino acid utilization. Sampling included whole-body composition, liver and visceral indices, and proximate analyses of both diets and carcasses. This data enabled calculation of optimal methionine levels specific to each strain.

The outcomes of this study contribute to improved feed efficiency and reduced reliance on costly imported supplements, supporting the development of sustainable aqua feeds tailored to indigenous species.

This research will provide crucial input for Zambia's aquaculture feed strategy, aligning with national goals to boost fish production and nutrition security using locally adapted species and feed resources.

THE CONTRIBUTION OF GHENT UNIVERSITY EDUCATION: PERSPECTIVES FROM PROFESSIONALS IN UGANDA'S AQUACULTURE SECTOR

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In 2012, I obtained an MSc in Aquaculture from Ghent University, which marked the beginning of a transformative journey in my professional career. Over the past 13 years, I have leveraged the knowledge and skills acquired at Ghent to drive significant advancements in Uganda's aquaculture sector through research, innovation, and community engagement. One of my key contributions has been the establishment of a biofloc facility at Buloba Country Home. This facility comprises five tanks with a total capacity of 120,000 litres, providing a sustainable and innovative approach to fish farming. Additionally, in collaboration with the European Union and other partners under the PrAEctiCe project, I have facilitated the introduction of a solar-powered modular aquaponic system in Uganda, promoting energy-efficient and integrated fish and vegetable farming. Beyond infrastructure development, my efforts have extended to community engagement and education through training farmers in proper pond management, disease prevention, and environmentally friendly aquaculture practices. These initiatives have contributed to improved food security and economic growth in Uganda but also in the broader East Africa aquaculture industry. Despite Ghent University's instrumental role in building the capacity of Ugandan students, several challenges hinder their full potential in aquaculture. Key obstacles include technical limitations in microbial metagenomics and artificial intelligence, along with inadequate access to modern aquaculture infrastructure. To overcome these challenges, it is essential to increase investment in education, secure research grants, and establish strategic partnerships with the private sector. Such measures would significantly enhance the contributions of Ugandan graduates to the aquaculture industry. With the right support and resources, students trained at institutions like Ghent University have the potential to drive further advancements in aquaculture, ultimately fostering a more resilient and sustainable industry for the future.

84 YEARS OF UGANDA'S AQUACULTURE: GROWTH, CHALLENGES, AND FUTURE PROSPECTS

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Aquaculture in Uganda has undergone remarkable growth and transformation since its inception in the 1941. Over the past 84 years, it has evolved from a small-scale subsistence practice into a key driver of food security, economic development, and export revenue. This transformation has been driven by technological advancements, supportive government policies, and private-sector investment. Specifically, a pivotal shift occurred in the early 2000s when Uganda government actively began promoting commercial aquaculture. This, coupled with the adoption of cage production systems sparked a continuing upward trend in annual aquaculture output, rising from approximately 820 MT in 2000 to 138,558 MT in 2021. Despite the impressive trajectory, the industry still faces major challenges, including limited investments, gaps in science and technology, inadequate fish seed and feed production, and an underdeveloped value chain. Amidst these challenges, there is substantial potential to further develop the aquaculture sub-sector and meet the growing demand for fish, driven primarily by the rapidly growing population. The review indicates that aquaculture production has been expanding significantly and is poised to play a leading role in ensuring food, nutrition and income security in Uganda.

STERILITY INDUCTION AND GROWTH PERFORMANCE ENHANCEMENT IN MALE *Oreochromis shiranus* USING *Acacia nilotica* AND *Carica papaya*

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In the quest for sustainable aquaculture practices, reproductive control especially in farmed precocious-breeding fish remains a key challenge. This study explored the use of *Acacia nilotica* aqueous pod extracts and *Carica papaya* seed powder as natural agents for inducing sterility in male *Oreochromis shiranus*, while simultaneously evaluating their effects on growth performance, body composition, and safety.

Male fish were reared in tanks and hapas at LUANAR Fish Farms (Bunda), receiving diets supplemented with varying levels (0, 5, 10, and 15 g/kg) of the plant materials for 16–18 weeks. Cytotoxicity testing using the Brine Shrimp Lethality Assay revealed that *A. nilotica* was non-toxic (LC_{50} = 108.95 mg/mL). Reproductive assessment showed significant reductions in gonad weight, sperm motility, and testicular integrity, with histological evidence of spermatogenic depletion and tissue necrosis at higher dosages.

While growth parameters remained largely unaffected across treatments, the 15 g/kg group demonstrated the highest specific growth rate and survival. Treated fish exhibited increased protein and ash content, with reduced fat levels, suggesting improved body composition. Residual saponin content declined from 5.03% to 1.76% within four weeks post-treatment, supporting food safety assurance.

These findings indicate that *A. nilotica* and *C. papaya* possess dual functionality—acting as effective reproductive inhibitors and nutritional enhancers—positioning them as promising natural alternatives for reproductive management in aquaculture. Further research is warranted to assess long-term physiological effects and application in female fish.

GROWTH PERFORMANCE AND YIELD OF TOMATO (ANJA F1) IRRIGATED WITH WASTEWATER FROM RECIRCULATING AQUAPONICS SYSTEM

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Aquaculture systems generate large amounts of waste, which may constitute a lucrative alternative for horticultural crop fertigation. With the ever-increasing global water scarcity, dual use of water for crop and fish production has the potential to optimize water use, dispose of aquaculture wastes, provide additional nutrients to crops, and reduce inorganic fertilizer usage. Therefore, the need to increase sustainable food production and match the food security demands under climate change impacts generates the force for developing circular water-energy-nutrient systems of integrated aqua-agriculture. In the light of this, a recirculating aquaponics system has been established at the Aquaculture Research and Development Centre, in Uganda to investigate the effect of fish effluent on growth performance and yield of crops.

This greenhouse study was conducted to determine the effects of fish effluents on the growth performance and yield of tomatoes (Anja F1). Approximately 120 seedlings were transplanted in potting bags and placed 50cm apart. These comprised of three treatments in triplicate, the control with tomatoes irrigated with underground water, one receiving water from Nile Tilapia tanks and another from African catfish tanks. One-way ANOVA test was conducted to identify the significant differences amongst the treatment means, and Tukey's HSD test was used to determine the source of variation. Results showed that tomatoes yields recorded a significant difference between the treatment means; irrigation of Anja F1 tomato variety with *C. gariepinus* effluent significantly ($P< 0.05$) increased the yield with respect to clusters per plant, number of fruits per cluster and number of fruits per plant. This research underscores the urgent need for adaptive management strategies to mitigate the adverse effects of using organic fertilizers. Therefore, the use of *Clarias gariepinus* effluent can be a viable alternative for smallholder farmers, for whom inorganic fertilizers are often expensive to afford or inaccessible.

Table 1: Average specific growth rates of the shoot and leaf length and leaf width of the different irrigation treatments

Treatments (Day1-39)	Growth (cm/day)		
	Shoot length	Leaf length	Leaf width
Water-Control	2.4	0.23	0.12
Tilapia Effluent	2.55	0.26	0.12
African Catfish Effluent	2.63	0.25	0.13

Key; Values with different superscript letters in the same column are statistically significant

Table 2: Means of the number of clusters of per plant (NCP), number of fruits per cluster (NFC) and number of fruits per plant (NFP) of Tomato variety Anja F1

Treatments	Yield		
	NCP	NFC	NFP
Water-Control	3.64^a	1.91^a	6.55^a
Tilapia Effluent	5.04^b	2.89^b	8.29^b
African Catfish Effluent	5.27^b	3.25^b	9.64^b

MAXIMIZING AQUACULTURE RETURNS IN UGANDA: A DUAL STRATEGY FOR SUSTAINABLE GROWTH IN SUB-SAHARAN AFRICA

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Uganda's aquaculture sector—key to Sub-Saharan Africa's 11% annual growth—has expanded rapidly, from 800 tons in 2006 to over 123,000 tons in 2020. This growth is driven by declining wild fish stocks and increasing demand. With abundant water resources and favorable conditions, Uganda primarily relies on pond and cage farming systems. This study evaluated the productivity, profitability, and investment potential of these systems, offering evidence-based strategies for sustainable aquaculture development in Uganda and the broader region.

Using a mixed-method approach, we examined small- and medium-scale farms operating for at least five years, selected through purposive and snowball sampling. The analysis focused on Nile tilapia production, comparing productivity indicators, cost structures, and economic returns between pond and Low Volume High Density (LVHD) cage systems, while integrating regional trends for broader relevance.

The findings reveal significant differences: ponds yielded 0.63 kg/m³ with a profit of USD 0.17/kg, whereas cages produced 27 kg/m³ with USD 1.20/kg profit.

Cages also supported faster production cycles (two per year vs. one), higher biomass, and lower variable costs (USD 1.10/kg vs. USD 2.10/kg). However, fingerling production in ponds generated the highest revenue (USD 256.60/m³), far outperforming grow-out ponds (USD 1.45/m³) and cages (USD 61.87/m³). Market prices stabilized after 2016, enhancing the resilience of cage farming and the attractiveness of fingerling production.

The study recommends a dual investment strategy: utilize ponds for fingerling production and LVHD cages for grow-out operations. This integrated approach maximizes profitability and sustainability, offering a scalable model for aquaculture growth in Uganda and across Sub-Saharan Africa.

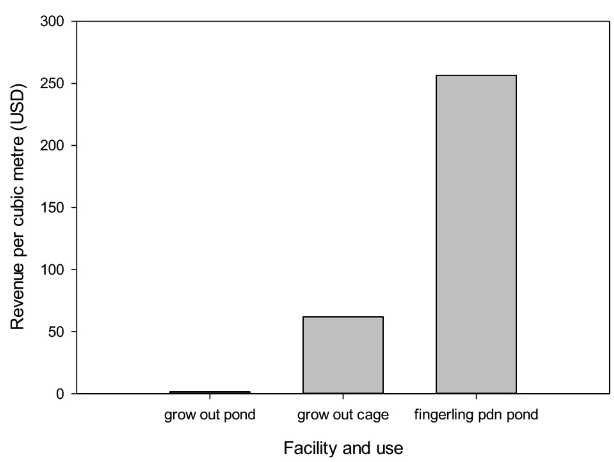

Figure 1: *Revenue per cubic metre of production facility per year*

SOIL-DRIVEN VARIABILITY IN NILE TILAPIA O*reochromic niloticus* GROWTH IN EARTHEN PONDS IN CENTRAL AND NORTHERN UGANDA

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Aquaculture is a significant livelihood activity in Uganda, with an estimated annual production of over 120,000 tons of finfish, primarily Nile tilapia. Earthen ponds, mostly operated by small-scale farmers, dominate the aquaculture landscape. Nile tilapia is widely cultured due to its fast growth, environmental tolerance, and flexible diet. However, wide regional disparities in tilapia growth and survival persist, even under similar temperature and feeding conditions. This suggests other influencing factors, such as soil-water interactions, which remain poorly understood by farmers. Accordingly, this study investigated the role of soil properties in influencing fish growth and yield in earthen pond aquaculture systems in Uganda.

Soil samples were collected from pond farms across Uganda, particularly in the Northern and Central regions. A 60-day controlled experiment was conducted at the Aquaculture Research and Development Centre, Kajjansi, using six soil treatments and one control (no soil), set in triplicate groups, each replicate stocked with 80 Nile tilapia (average body weight: 1.54 g). All treatments were managed under identical feeding and environmental conditions. Soils from both regions were predominantly sandy clay loam, with no significant regional differences in texture. However, the treatment with the highest organic matter, cation exchange capacity, calcium, and potassium yielded the greatest factorial increase in fish body mass and the best feed conversion ratio (Table). This treatment also produced fish with the highest phytoplankton abundance in gut content. Interestingly, while the control exhibited the highest water column phytoplankton productivity and diversity, it yielded the lowest factorial increase in body mass and survival rate. This reveals that despite the importance of natural and artificial feeds in pond aquaculture, treatments that had soil all performed better than the control.

Therefore, soil properties significantly influence pond productivity and fish performance in earthen aquaculture systems. Despite often being overlooked, soil quality, particularly nutrient content and chemical characteristics can be a key limiting factor in Nile tilapia yields. Thus, this study underscores the need for integrated pond management approaches that incorporate soil testing and amendment practices to enhance aquaculture productivity in Uganda.

			Water Column-Phytoplankton		Gut Content-Phytoplankton
Soil Sources	**Factorial Increase Body Mass**	**FCR**	**Diversity**	**Abundance (%)**	**Abundance (%)**
Control	4.59	2.16	0.91	18.66	14.05
Masaka	5.16	1.95	0.66	17.16	12.64
Wakiso	4.74	2.17	0.58	13.43	13.54
Buikwe	4.69	2.19	0	11.19	11.49
Amuru	4.88	2.06	0.15	11.94	10.98
Kitgum	5.45	1.85	0.49	12.69	19.54
Omoro	5.09	1.95	0.53	14.93	17.75
P-Value	**0.24**	**0.423**	**0.219**	**0.075**	**0.579**

Therefore, soil properties significantly influence pond productivity and fish performance in earthen aquaculture systems. Despite often being overlooked, soil quality, particularly nutrient content and chemical characteristics can be a key limiting factor in Nile tilapia yields. Thus, this study underscores the need for integrated pond management approaches that incorporate soil testing and amendment practices to enhance aquaculture productivity in Uganda.

REDUCING POST-HARVEST LOSSES IN FISH VALUE CHAINS IN THE SOUTHERN AFRICAN DEVELOPMENT COMMUNITY REGION

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Although global consumption of aquatic foods has increased by 3 percent annually, high post-harvest losses (PHLs) remain a concern in fisheries and aquaculture value chains. In Africa where malnutrition and food insecurity are proliferating, PHLs are causing enormous economic losses and affecting livelihoods of fish value chain operators. This is because aquatic foods are highly perishable, and their quality begins to deteriorate immediately after being harvested. Inadequate infrastructure, lack of knowledge, and technical capacity of the value chain actors especially women, exacerbate the situation leading to quality, market, and physical losses. Globally, post-harvest losses account for 10% of total fish losses, while in Southern Africa losses are estimated at an average of 25%. If the SADC region has to improve food and nutrition security, actors in the fish value chains have to make better use of fish produced by reducing PHLs and increasing fish available for consumption. SADC through the PROFISHBLUE project is supporting women and youth engaged in processing and trade of fish and fish products in seven SADC countries to reduce PHLs. Out of the total of 9,277 targeted participants, 93% ($P < 0.05$) are women and 53% are youths. By imparting knowledge and technical capacity in fish processing including value addition, providing cold chain, and marketing infrastructure, fish losses along the value chain can be reduced while increasing fish consumption, improving livelihoods and economic gains for over 380 million people in the region.

ECONOMIC VIABILITY OF PRODUCING BLACK SOLDIER FLY (*Hermetia illucens*) LARVAE AS A FISH FEED PROTEIN CONCENTRATE USING LOCALLY AVAILABLE WASTE SUBSTRATES

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Background

Over 50% of global fish is provided by aquaculture whose dependency on fish meal and oil for quality aqua-feed is unsustainable due to dwindling wild fish stocks and use of small pelagic fish species traditionally predestined for fish meal as human food. Edible insects especially black soldier fly larvae (BSFL) is promoted as an alternative sustainable source of feed protein and oil for animal production including aquaculture that consumes 60% of global fish meal. However commercial production of black soldier fly larvae is still low (4%) in Uganda. Inadequate information on profitability of the enterprise based on locally generated waste substrates is placed among key limiting factors (Siva Raman et al. 2022). We evaluated the viability of producing BSFL fed on three locally generated, nutrient rich organic waste substrates; brewery waste (BW), chicken waste (CW) and potato peelings (PP) for aqua-feeds.

Objectives of the study

To determine the effect of substrate type on BSFL weight gain, proximate nutrient composition of BSFL as a fish feed protein and profit margin of producing BSFL.

Materials and methods

A cross sectional study design based on an experimental study design was used. 59,100 five-day-old black soldier fly larvae (5DOL) were divided into nine (9) groups of 3,600 BSFL each that were randomly fed on 6 kgs of three wastes/substrates; brewery waste (BW), Chicken waste (CW) and Potato peelings (PP) whose proximate nutrient analysis is presented in Figure 1.

After 16 days, 50 NSFL were randomly selected and humanely killed by blanching (instant hot water treatment) as described by (Larouche 2019). Individual weight was taken while batches were dried and analysed for proximate nutrient composition and profit margin. Data on proximate nutrient composition (%) of crude protein and crude fiber was determined following standard analytical procedures by the Association of Official Analytical Chemists (AOAC 2000); and that on profit margin (%) derived according to (Shi et al. 2021) after sale of the BSFL produced from each substrate according to Equation 1

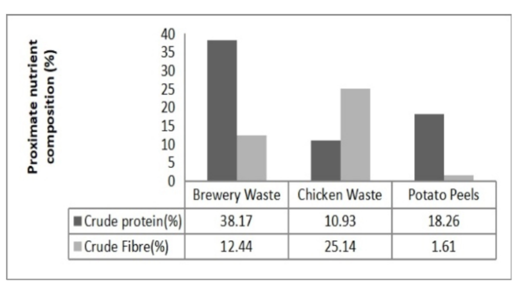

Figure 1: Proximate composition of Brewery waste, chicken waste and potato peelings used in the study

(Continued on next page)

Equation 1:

$$Profit\ margin(\%) = ((Total\ revenue - Total\ costs)/Total\ revenue) * 100)$$

The data on proximate nutrient composition was analyzed for variance of the mean (I way ANOVA) using R 4.4.1 software while data on profit margin (%) of producing BSFL was analyzed using descriptive statistics. The substrate that recorded BSFL with the highest weight gain, protein content and profit margin was declared as the most economically viable waste substrate.

Results

Mean live BSFL body weight (1.36±0.02g) did not significantly differ among substrates (Figure 2), mean crude protein (44.40±0.3%) statistically differed (Figure 3) while the profit margin was negative for CW(-33.64%) and positive for BW(19.44%) and PP (8.12%) (Figure 4).

Crude protein; CP (%) content of BSF larvae was statistically significantly different among study organic wastes/ substrates (df=2, F=10.68, p=0.0007) (Figure 3 while crude fibre of the BSFL did not statistically significantly differ among the substrates (df=2, p=0.66, F=0.43), Figure: 4

The gross profit from BSF larvae fed on brewer's waste, potato peelings and chicken waste (without considering costs of the housing) ranged from -16,698.86 shillings to 15,858.00 shillings (USD$ -4.39-4.17) being higher for BSFL fed on brewers' waste (Table:1).

Results reveal that the weight gained by the 5 old days BSF Larvae increased from … to ….and was not influenced by the substrate type while crude protein was over 38% and profit margin -16,698.86 to 15,858.00 shillings (USD$ -4.39-4.17).

6. 1 Conclusion

BSFL farming is a viable enterprise if appropriate substrates such as brewery are used

Recommendation

Formulation of specified multi-nutrient black soldier fly concentrates for the various development stages is required to advance the sustainability of the venture.

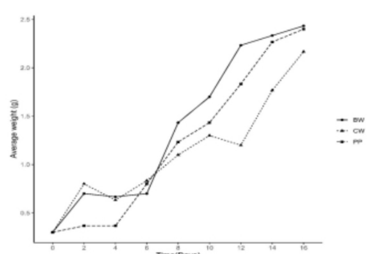

Figure 2: Weight gain trends of black soldier fly larvae over 16-days rearing period

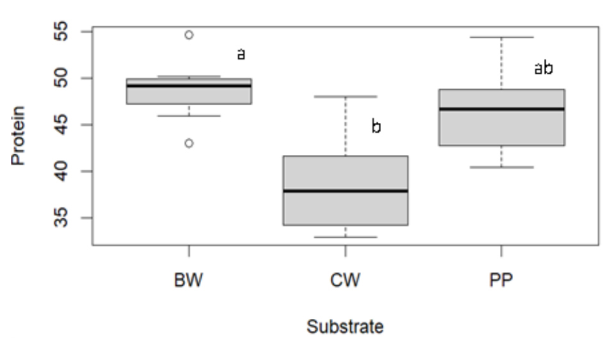

Figure 3: Box plots for crude Protein content in the BSF larvae fed on the three waste substrates

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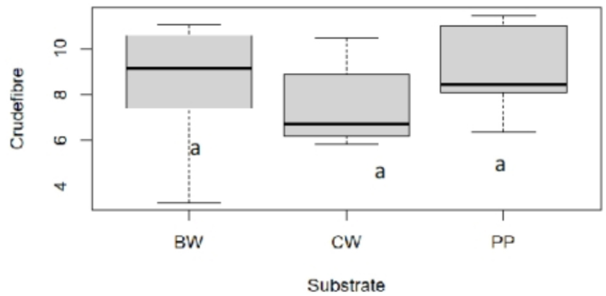

Figure 4: Box plot of Crude fibre (%) for BSF fed on the three waste substrates

Table 1: Revenue generated rearing substrate when culturing black soldier fly larvae

Particulars	Brewery waste (BW)	Chicken waste (CW)	Irish potato peels (PP)
Cost of 5DOL	48,000.00	48,000.00	48,000.00
Cost of substrates (6Kg)	840.00	3,600.00	1,500.00
Costs of basins (20Ltrs)/kg	15,000.00	15,000.00	15,000.00
Total costs	**65,700.00**	**66,342.86**	**65,160.00**
Average weight gain of larvae (g)	0.23	0.14	0.20
Number of larvae	177,300.00	177,300.00	177,300.00
Total weight (kg)	40.78	24.82	35.46
Unit price /kg of live Larvae	2,000.00	2,000.00	2,000.00
Revenue from the sale of larvae (Ushs)	**81,558.00**	**49,644.00**	**70,920.00**
Net profit from larvae (Ushs)	**15,858.00**	**-16,699.00**	**5,760.00**
Profit margin (%)	**19.44**	**-33.64**	**8.12**
Revenue for 16 days	15,858.00	-16,699.00	5,759.80
Revenue per month (*2)	31,715.54	-33,398.00	11,519.60
Revenue per g/round	158.58	-166.99	57.60

Exchange rate: 1USD = 3800 Shillings

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DESIGN AND DEVELOPMENT OF A NOVEL OFFSHORE CAGE DESIGN FOR INTEGRATED MULTITROPHIC AQUACULTURE

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Offshore aquaculture is gaining popularity due to the immense pressure on land and near-shore-based water resources and the escalating marine pollution in the near-shore areas. A variety of offshore cage designs are available with various distinct configurations and geometry to withstand harsh sea weather conditions. However, most of them are in their infancy and are limited to developed countries that have sophisticated infrastructures to support the development, deployment, and operations of cage designs as well as sustainable aquaculture systems such as Integrated Multi trophic Aquaculture (IMTA) system. Therefore, a novel stratified fish cage design that can allow maximum uptake of nutrients in an IMTA setup was developed in this study. The design integrates distinct configurations that would allow offsetting of the drag forces experienced due to the high ocean current and wave forces. The viability of this cage was demonstrated through experiments conducted in a wave tank. The predicted numerical model of the designed cage was validated by comparing it with the experimental model and previous research studies that employed polarcirkel cages of the Akva group. The mean relative error between the experimental and the predicted numerical forces was about 15.3%, which is within the safety of factor and design considerations as per the Det Norske Veritas and Germanischer Lloyd (DNV-GL) guidelines.

Moreover, this research study aimed to address the possibility of a stratified cage design for maximum uptake of nutrients in an open sea. To address the issue of the structural response of the cage to the sea environmental loadings, tensions on the mooring were examined under varying current and wave conditions, providing information on the expected mooring forces for a stratified cage with amalgamated design configurations. The results of this study provide data on the expected anchor loads for the design of a stratified aquaculture cage in an offshore environment, precisely the maximum expected load-bearing capacity of any anchor.

SUITABILITY STUDY FOR CAGE FISH CULTURE IN LAKE TURKANA: ADVANCING FISHERIES AND EXPLORING ORNAMENTAL FISH AQUACULTURE

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Lake Turkana, the largest desert lake in the world, presents a unique opportunity for advancing aquaculture through cage fish culture. A feasibility study conducted by Kenya Fisheries Service, Kenya Marine and Fisheries Research Institute (KMFRI), and Turkana County Government identified Kalimapus Beach as a suitable pilot site. Environmental parameters, including physicochemical water quality, exposure to wave action, and substrate conditions, were analyzed across multiple Beach Management Units (BMUs). Findings indicate the lake has potential for large-scale tilapia farming, contributing to food security, employment creation, and reduced pressure on capture fisheries. Additionally, this study explores the possibility of cage culture for ornamental fish, leveraging Lake Turkana's biodiversity and natural water clarity. The introduction of high-value ornamental species could expand the economic base, promote sustainable aquaculture, and attract investment in niche markets. Establishing land-based hatcheries at Impressa Beach would support stable fingerling production, ensuring continuous supply for commercial ventures. Recommendations include piloting cage structure designs tailored to local conditions, addressing market dynamics, and engaging stakeholders for socio-economic integration. Successful implementation could position Lake Turkana as a hub for both food and ornamental fish aquaculture, fostering the blue economy's growth in Kenya.

WILL FISH OVERCOME BEEF? A PEEK INTO BOTSWANA'S AQUACULTURE STRATEGY

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Globally, aquaculture is one of the fastest growing food producing sectors, and a major source of the economy. However, most African countries have not benefited from the opportunities available in this sector. Botswana, in particular, has one of the lowest fisheries and aquaculture production figures in the region as a result of limited water resources and capacity, very low fish consumption in comparison to beef and little exposure to the benefits of aquaculture. These factors are compounded by largely dry, hot conditions and increasing impacts of climate change. The Southern Africa Development Community (SADC) region developed a Regional Aquaculture Strategy and Action Plan to assist member states to leverage the value and benefits of this sector. Therefore, the Botswana Aquaculture Strategy was developed within this framework. The FAO's Code of Conduct for Responsible Fisheries and the SADC Protocol on Fisheries were consulted to provide the legislative framework for the development of this strategy. Currently, the only fisheries centric legislation in Botswana are the Fish Protection Act of 1975 and the Fish Protection Regulations of 2016 which however, focus more on management of wild capture fisheries than on aquaculture. Apart from these, Botswana does not have either a national fisheries or aquaculture policy. The absence of a policy framework, and an arid climate, has resulted in low growth of the aquaculture sector in Botswana. However, despite these challenges, there have been several developments in the sector which suggest that there are still opportunities for aquaculture growth in the country. These include among others, the presence of one large commercial operation, a national hatchery, permanent water bodies in northern Botswana and several dams in south-eastern Botswana. Furthermore, the strengths and opportunities identified from a SWOT analysis of Botswana's aquaculture sector revealed that these outweigh the identified threats and weaknesses in the sector. Moreover, the identified weaknesses are challenges that can be addressed through development of robust action plans while threats can be addressed through proactive regional and international bi-lateral engagements and planning. Through assessing the level of alignment of the national aquaculture strategies/plans/programmes of Botswana, Malawi and Namibia with the SADC Regional Aquaculture Strategy and Action Plan; aligning and mainstreaming the regional strategy in the three national strategies/plans/programmes; an aligned aquaculture strategy has been developed for Botswana. The goal of the strategy is to increase the contribution by aquaculture to local and national socio-economic growth and trade by 2036. With a mission to create a sustainable, competitive and diversified aquaculture sector in Botswana, the strategy envisions an aquaculture sector in Botswana that will contribute significantly to not only the national GDP and Blue Economy, but also to socio-economic development, as well as food and nutrition security in the country.

REFLECTIONS ON THE CAREER OUTCOMES OF AQUACULTURE EDUCATION: A NETWORKING EVENT

TOPIC: INCORPORATING BUSINESS SKILLS AS A TOOL FOR AQUCULTURE DEVELOPMENT

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Aquaculture in Uganda contributes 20% to fisheries production, supporting economic growth and food security. Despite this, challenges such as seed and feed shortages, poor marketing, and climate change hinder its progress. Achieving the national production target of one million tons requires strong business skills, including understanding business ownership models. These may include; personal, family-owned, group-owned, public-private, governmental, and non-governmental. Incorporating business skills like entrepreneurship and innovation into aquaculture development is vital to enhancing production efficiency and sustainability. Students need practical business skills to link science with business.

Tools like SWOT analysis could be used to choose the business model to adopt. For example, public-private partnerships leverage governmental support in the form of funding and technical support. Similarly, cooperative models can enhance local participation and shared resource management; bulk purchasing and price regulation can be achieved by farmers under this. Family businesses are also good models that ensure the longevity and development of enterprises. Focus areas for training to be adopted for business are value chain development, financial management, taxes, project management, marketing, governance, policy, and insurance, among others.

By linking technical aquaculture training with business education, students and local fish farmers gain the capacity to translate scientific innovations into profitable ventures. This dual competency will foster entrepreneurship among Uganda's youth (who represent 70% of the population) and integrate sustainable practices into the broader spectrum of general business management. The impact will be a resilient aquaculture and business sector that meets current production targets, reduction of employment gaps, and increase of revenue, among others.

LESSONS FROM THE GENETIC IMPROVEMENT OF *Oreochromis andersonii* in ZAMBIA

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Introduction

Oreochromis andersonii is a key indigenous aquaculture species in Zambia and for long has depended on genetically unimproved fish seed. One of the challenges in using unimproved strains, is their slow growth rate and higher feed conversion efficiency compared to improved commercial strains such as *Oreochromis niloticus.* The genetic improvement program (GIP) of *Oreochromis andersonii*, started with the objectives of improving growth and supplying high-quality genetically improved indigenous fish seed. The trait of interest is growth rate. This abstract outlines essential steps in the practical development of the GIP and highlights the lessons learned at each stage. These steps entailed establishing a nucleus site, collection of founder stock, disease screening, genetic characterization, staff engagement, hatchery establishment, egg incubation, nursing of fry in hapas and management of produced founder and successive generations.

Objectives

1. Establishment of the genetic improvement program for *Oreochromis andersonii*.
2. Document processes and lessons learned at each stage of the program.
3. Provide recommendations for future genetic improvement initiatives.

Methodology

Founder stocks were collected and screened for key tilapia diseases. Clean diverse broodstock were used as founders to ensure the establishment of a healthy and genetically diverse breeding program. Establishment of a functional and cost-effective hatchery for producing an adequate number of families simultaneously. Staff were trained and secure nursing and broodstock facility set up to manage and grow-out the produced generations.

Conclusion

The genetic improvement program for *Oreochromis andersonii* in Zambia has provided valuable insights into effective aquaculture practices. The GIP has been tailored to local environmental conditions and production system and will improve the genetic quality of available aquaculture seed, build national capacity in fish genetics and breeding and ensure equitable access to improved seed for small and medium scale farmers across the country. Key lessons include the need for comprehensive disease screening, the importance of genetic diversity, the role of skilled personnel, and the benefits of well-managed infrastructure. Future programs should build on these lessons to further enhance the productivity and sustainability of aquaculture in the region.

GENDERED VALUE CHAIN OPPORTUNITIES AND CHALLENGES IN SEAWEED AQUACULTURE: AN OVERVIEW OF THE CHANGING GENDER AND SOCIO-ECONOMIC DYNAMICS IN MWAZARO AND KIBUYUNI VILLAGES, SOUTH COAST KENYA

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Seaweed aquaculture is a vital economic activity that contributes significantly to livelihoods and food security in coastal regions worldwide. In Kenya, particularly in Mwazaro and Kibuyuni villages, seaweed farming has emerged as a key livelihood source, fostering economic resilience and gender empowerment. This study examines gender-associated opportunities and challenges within the seaweed value chain, emphasizing labor distribution, economic contributions, and barriers to participation. A mixed-methods approach was employed, incorporating both qualitative and quantitative data from 155 respondents (126 women, 29 men). Findings indicate that women dominate the sector, engaging in production, harvesting, and processing, while men largely control marketing and price negotiations. Farmers earn an average of USD 56 per 45-day production cycle, with variations from USD 10 to USD 120, reflecting income disparities. Approximately 40% reinvest their earnings into household needs, while 35% diversify into small-scale businesses. Women were actively engaged in all value chain nodes, with production and harvesting tasks shared equally between men and women, while value addition remained female-dominated and marketing largely male-dominated. These patterns highlight the gendered nature of labour division within the sector, carrying implications for economic empowerment, gender equality, and sustainable development interventions to foster inclusive growth in coastal communities. The income generated from seaweed farming enabled women to support their households, particularly in educating their children and investing in other local enterprises. Additionally, access to resources and frequent training sessions enhanced their technical capacity, equipping them with the necessary skills for decision-making in seaweed enterprises. Key challenges include insufficient financial resources (63%), inadequate training (55%), and climate change-induced disruptions (70%), leading to a 30% decline in harvests over the past three years. Additionally, lack of access to farm inputs (48%) and market linkages hinders expansion efforts. Despite these barriers, the study underscores that the economic and social benefits outweigh the challenges, highlighting the need for gender-responsive policies that enhance financial support, capacity building, market linkages, and climate adaptation strategies. The findings suggest that targeted interventions addressing financial and market disparities can significantly enhance gender equity and sector sustainability. By strengthening women's participation in high-value activities, seaweed aquaculture can contribute to inclusive economic growth and resilience in coastal communities.

MITIGATING CLIMATE CHANGE THROUGH COMMERCIAL SEAWEED FARMING ALONG THE KENYAN COAST

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Long-term shifts in temperatures and weather patterns associated with climate change have significant negative impacts on biodiversity, livelihoods, food safety among others. Application of innovative aquaculture interventions focused to promoting climate smart agriculture for sustainable economic growth are critical in Kenya. In the present study we highlight the critical role that seaweed farming play in marine ecosystems by supporting biodiversity, enhancing coastal resilience and mitigating the impacts of climate change besides contributing significantly to local economies and providing livelihoods for coastal communities in Kenya.

RIDING THE WAVES OF CHANGE: CHALLENGES, INNOVATIONS AND THE FUTURE OF SEAWEED FARMING

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Climatic variation poses a significant threat to global seaweed production and fisheries, yet little is understood about its impacts on small-scale aquatic food systems. This study investigated the dynamics of restorative seaweed production in five farming villages in Kwale County, Kenya. It focused on the impact of environmental stressors, technological limitations, and socioeconomic factors. Individual questionnaire interviews, encompassing both open-ended and closed-ended questions, were utilised. The study employed a clustered randomised sampling design, and the Kobo Toolbox was used to collect data. The survey revealed that climate variability, particularly during the strong southeast monsoon (SEM) winds, caused the uprooting of seaweed, while the northeast monsoon (NEM) brought disease (ice-ice) and epiphytes, thus significantly impeding seaweed biomass production and carrageenan quality.

A temperature rise was identified as the most severe environmental stressor (42%). The impact was magnified by several constraints, such as the lack of harvesting boats (74%) and boat engines (39%). Security concerns were prevalent, with 44% reporting theft of either seaweed (37%) or tools (63%), which further magnified the losses, especially during extreme weather events. Farmers exhibited varied responses to ice-ice disease, with 37% cutting affected areas and 24% drying diseased plants. A substantial majority (78%) lacked seaweed farming calendars; however, 92% expressed a strong desire for this guidance tool.

Despite being an environmentally sustainable aquaculture practice, the study underscores the need for alternative farming systems like a raft and long-line methods that can withstand harsh climatic changes. The detrimental impact of epiphytes on biomass and carrageenan quality during certain times of the year necessitates innovative solutions. Therefore, there is a need for innovations to address changing climatic conditions, diversification and expansion of seaweed farming to deep and stable (in terms of water quality) offshore waters using innovative methods to ensure sustainability.

PATTERNS OF FISH JUVENILE RECRUITMENT IN THE CRITICAL COASTAL HABITATS AND SEED AVAILABILITY INSIGHTS IN KIJIWENI, KENYA

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Marine and coastal habitats, such as mangroves, seagrasses, and coral reef, are vital for the abundance and diversity of fish juveniles, which play a critical role in supporting future fish stocks and sustaining fisheries and aquaculture. With a majority of the population relying on subsistence fishing, declining catches due to overfishing have prompted a shift to small-scale aquaculture. Yet, the consistency of seed supplies remains a challenge for its long-term viability. This study aimed to investigate fish juvenile recruitment patterns in the mangrove, seagrass and coral reefs habitats and explore solutions for enhancing coastal community welfare and marine resource sustainability. Monthly samplings of fish juvenile and physiochemical parameters were conducted in Kijiweni, Kwale County, from August 2021 to August 2022. A total of 244 fish species belonging to 54 families were recorded, with a dominance of species belonging to the family pomacentridae, Sphyraenidae, Apogonidae, Hemiramphidae and particularly Siganidae (rabbitfishes), a potential mariculture species for culture in the Kenyan coast. Recruitment showed monthly variations, peaking in August 2021 and Noevember 2021, while September 2021 and May 2022 had the lowest juvenile numbers. Notably, the distribution of *Siganus sutor* varied seasonally. Seagrass habitats emerged as the top recruitment zones for *Siganus* sp*,* followed by mangroves and coral reefs. Hydrographic parameters, including temperature and salinity, followed similar patterns to fish juvenile abundance, suggesting their potential influence on fish juvenile recruitment in coastal habitats. This study provides vital understanding of fish juvenile recruitment in the key coastal habitats, underling the need for conservation for the sustainability of fisheries, and importantly gives essential advice to small-scale farmers depending on wild seeds about the best timing for seed collection.

EVOLUTION OF A HOLOLIMNETIC LIFE HISTORY: COMPARING GENETIC DIFFERENTIATION AND LIFE HISTORY TRAITS IN EAST AFRICAN FRESH/BRACKISH WATER PRAWNS *Macrobrachium lepidactylus* AND WIDESPREAD *M. rude* (CRUSTACEA, DECAPODA, CARIDEA)

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Introduction: Globally, the prawns of the genus *Macrobrachium* comprises of about 243 species across the tropical and sub-tropical regions. This includes about 8 species reported in Kenya. *Macrobrachium* are important human food sources and also play many ecological roles although there is little information documented about their population genetics and the life history traits of *M. lepidactylus* and *M. rude* in Kenya including divergent lineages *en route* to form new species and test in each lineage whether or not larval development require marine conditions. Lineages that do not rely on saltwater for larval development would provide a great advantage in aquaculture.

Methods: All the population genetics analysis was carried out in the laboratory at Johann Wolfgang Goethe- University of Frankfurt/Main, Germany between year 2015-2018. Mitochondrial DNA (COX1) gene sequences were analysed using ARLEQUIN software ve 3.5.1.

Results and discussion: The results of this study based on analysis of the haplotype networks, pairwise F_{ST} and Analysis of Molecular variance (AMOVA), genealogical tree and the genetic divergence differences between the upstream and coastal populations of *M. lepidactylus* showed similar patterns of groupings suggesting genetic similarity although with a reduced gene flow. This suggest an ongoing incipient speciation event although it is difficult to state clearly at this moment that there is a clear evidence for independently evolving— and thus, potentially sympatrically speciating—divergent mitochondrial lineages. The results on the egg size differences indicated significantly larger eggs for the upstream than coastal populations which is consistent with evolution to a completely freshwater existence. On the contrary, the haplotypes of the individuals with larger egg sizes did not appear in the exclusive upstream diverging population suggesting that hololimnetic evolution is an independent evolutionary event.

Conclusions and recommendations: Therefore with caution, the two populations (upstream and coastal) of *M. lepidactylus* should be managed as distinct genetic stocks and the population which appears to be adapted to freshwater conditions can be highly suitable for aquaculture. On the other hand, the populations of *M. rude* revealed no population genetic structure suggesting gene flow and should be managed as a single genetic stock. Both species showed high genetic diversity suggesting good survival and breeding potential. Thus, the genetic definition of prawn stock structure is important in understanding of fisheries resources for informed conservation and to ensure the sustainability of prawn fisheries in aquaculture.

BIOGEOGRAPHY AND EVOLUTIONARY RELATIONSHIPS OF THE AFRICAN PRAWNS GENUS *Macrobrachium* ON A GLOBAL SCALE: INDIAN OCEAN SURFACE CURRENTS AS A SPECIES PUMP FOR *Macrobrachium* SPECIES

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Introduction
The prawns of the genus *Macrobrachium* comprises about 243 species globally and plays important ecological roles as well as human food source. However, there is little information known about the phylogenetic relationships of the Kenyan/East African and other global congener species for better understanding of its evolutionary relationships, palaegeographic and diversification patterns among this group of species as well as sustainable aquaculture fisheries.

Methods
A multi-locus gene approach was used to reconstruct the phylogeny of *Macrobrachium* species to its congener species in the Neo- and Palaeotropics based on a concatenated data set of Cytochrome Oxidase 1 (COI), 16S rRNA, Histone 3 and 18S rRNA genes. All the laboratory molecular work was carried out at Johann Wolfgang Goethe University Frankfurt/main, Germany between year 2015-2018 and all sequences reposited in gene bank.

Results
Four species of *Macrobrachium* were confirmed to occur in Kenya namely, *Macrobrachium rude, M. dolichodactylus, M. equidens* and *M. lepidactylus*. The phylogenetic tree results also confirmed the genus *Macrobrachium* as monophyletic although the Kenyan/East African *Macrobrachium* species were not monophyletic and formed three distinct monophyletic clades that clustered well with the Indian, East and South East Asian sister species indicating their close genetic similarity. This suggest allopatric speciation after larval drift of *Macrobrachium* in the Indian Ocean occasioned by favorable surface ocean currents that provided ecological connectivity although it is a rare event in geological time scales. However, *M. lepidactylus* appeared in an isolated position on the phylogenetic tree and clustered with sister species from Africa only, suggesting endemicity to the African continent.

Conclusion
The results of this study support the evolution of species with abbreviated larval development (hololimnetic) occurring multiple times being non- monophyletic and occurred in different lineages suggesting multiple origins. In summary, this study has generated new information regarding evolutionary history of Kenyan/African *Macrobrachium* species for informed conservation and management measures and sustainable aquaculture.

EMPOWERING WOMEN IN AFRICAN FISHERIES – BREAKING BARRIERS, BUILDING FUTURES

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Women are the backbone of Africa's blue economy, driving both capture fisheries and aquaculture. Despite their dominance in trade and processing—accounting for over 70% of these roles—women face systemic barriers, including limited access to technology, exclusion from decision-making, financial constraints, and climate vulnerabilities.

We highlight the transformative initiatives led by AWFISHNET to address these challenges.

Through advocacy, capacity building, and market access programs, AWFISHNET has empowered women across the continent, from Uganda's hygienic processing training to Kenya's eco-certification linkages. The call-to-action urges policymakers, the private sector, and donors to prioritize gender-responsive investments, showcasing success stories like Rwanda's doubled output in women-led cooperatives. The future of Africa's fisheries and aquaculture hinges on equity, resilience, and the untapped potential of women, proving that their leadership is indispensable for sustainable growth.

JUMP-STARTING SUSTAINABLE AQUACULTURE DEVELOPMENT IN AFRICA: THE CONTRIBUTION OF AFRICA'S NON-STATE ACTOR NETWORKS

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The Comprehensive African Agriculture Development Programme (CAADP) recognizes the imperative need for establishing broad and inclusive coalitions to strengthen policy, programming and institutional capacity for the sector's transformation. Under this framework, state and non-state actors (NSA's) become partners in development founded on establishing a common vision between the parties driven by collective responsibility, demonstrating synergies, complementarities, and mutual accountability. This approach is upheld in the Policy Framework and Reform Strategy for Fisheries and Aquaculture in Africa (PFRS) through the Africa Fisheries Reform Mechanism (AFRM). The AFRM is broad-based all-inclusive participatory process through which Africa's fisheries and aquaculture sector develops and implements common positions. The purpose of this was to promote the establishment all-inclusive fisheries and aquaculture institutions, value chains and markets rather than extractive ones centered on benefitting a few. The latter scenario being contrary to the PFRS which advocates equitable benefit sharing, as being key for the sustainable development of Africa's fisheries and aquaculture sector.

A key priority action of the African Union's Aquaculture Action Plan 2016-2025 is promoting and strengthening the capacities of aquaculture associations and networks to develop all-inclusive advocacy, awareness and developmental programs in support of equitable capacity building for the sustainable growth and coherent development of the sector. By so-doing, the aquaculture action plan has created a conducive environment that provides a level playing for aquaculture policy development, technology and education on the continent. This has led to the promulgation producer and professional aquaculture networks continentally, which in turn has mobilized resources, talents and skills from the broader majority fostering people-centered development actions and technological innovations that are proving to be transformative for the sector, particularly for women, youth and disadvantaged communities' businesses.

READINESS OF SMALL-SCALE FISH FARMERS FOR DIGITAL CLIMATE INFORMATION SERVICES IN SADC REGION: EVIDENCE FROM ZAMBIA

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Climate change poses a significant threat to the fisheries and aquaculture sector, particularly in developing countries like Zambia, where small-scale fish farmers face economic losses due to disrupted value chains, limited access to climate information, and weak adaptation capacities. Introducing digital climate information services (CIS) offers a critical solution by providing localized climate data and tailored advisories to enhance climate-informed decision-making and promote effective climate risk management among vulnerable small-scale fish-farmers. As part of the effort to develop a digital CIS for aquaculture, a survey with a sample of 300 smallholder fish farmers across three districts in Luapula province—Mansa, Kawambwa, and Samfya—located along Lake Bangweulu in Zambia was conducted to gather relevant information for creating a platform to mitigate climate risks in the aquaculture sector. The study aimed to assess the effects of climate change and weather variations on fish production among small-scale fish farmers in Zambia, evaluate the current status of climate change adaptation practices, examine the utilization of CIS, and identify preferences for weather information and communication mediums. Respondents were randomly chosen using registers from local authorities, ensuring representativeness across stakeholder strata.

The findings revealed that 74.8% of the respondents faced challenges due to changing weather patterns, with high temperatures and reduced rainfall being the most common issues. A statistically significant difference ($P<0.05$) was found between education levels and the challenges experienced from weather changes. There was also a significant relationship between the weather-affected fish production process and access to fisheries training, except for pond preparation, fingerling collection, and harvesting ($P>0.05$). Only 37.7% of respondents reported using weather information in their farming practices, primarily information related to low temperatures and heavy rainfall. Most of this information was accessed via radio, as financial constraints limited access to digital platforms such as social media or television. In terms of weather information preferences, most respondents desired updates on the onset of rains, critical temperatures, and heavy rainfall, with a preference for weekly updates. SMS messages in local languages were the preferred medium for receiving weather information, especially for pond preparation activities. The research also derived key actions taken by farmers based on specific weather information to minimize the risks posed by weather variations, information critical for the development of a framework according to changes in weather variables. The study recommends large scale capacity-building initiatives to ensure the readiness of small-scale fish farmers in using CIS effectively for managing climate risks in the SADC region.

SCALING SUSTAINABLE AQUACULTURE IN EAST AFRICA THROUGH PUBLIC-PRIVATE PARTNERSHIPS: LESSONS FROM FOODTECHAFRICA AND SAMAKI POA

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With over a decade of experience designing and implementing aquaculture-focused public-private partnerships (PPPs) across Africa and Asia, Larive International offers practical insights into how collaborative models can drive sustainable growth in the sector. This presentation will draw on our broader PPP experience, with a particular focus on two flagship initiatives in East Africa—FoodTechAfrica and Samaki Poa. These projects demonstrate how effective multi-stakeholder collaboration can be translated into concrete outcomes in aquaculture production, capacity development, and regional food security.

FoodTechAfrica (2012–2021), brought together 21 companies and academic institutions to develop a fully integrated aquaculture value chain across Kenya, Tanzania, and Rwanda. Achievements include the establishment of hatcheries, feed production facilities, fish farms, and vocational training hubs. The project also led to the creation of the Aquaculture Academy, which continues to build local technical capacity and promote best practices through initiatives such as the Best Fish Farmer Competition in Kenya.

Samaki Poa (2022–2026), supported by Norway, focuses on digital innovation and localized training to enhance productivity and reduce dependency on fish imports in Uganda, Kenya and Rwanda. The PPP leverages the expertise of private companies and training partners to improve capacity building and access to knowledge, access to quality inputs, and create sustainable employment opportunities.

This presentation will offer insights into the enabling conditions for successful PPPs, common implementation barriers, and practical approaches to adaptive program design. It will underscore the critical role of long-term capacity building and context-specific innovation in achieving sustainable outcomes. Drawing from our experience, including the challenges encountered and the innovative strategies we've applied—we aim to foster an open dialogue that informs future PPP strategies and strengthens collaboration among stakeholders committed to scaling aquaculture. Achieving lasting impact requires intentional design, strong local ownership, and the ability to adapt creatively to evolving needs and realities.

BEYOND THE NET: CATALYZING LIVELIHOOD DIVERSIFICATION THROUGH INSECT AND SPIRULINA FARMING IN BUIKWE DISTRICT, UGANDA

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Uganda's wild fish stocks have declined by 30–40% over the past decade due to overfishing, pollution, and climate stress. To meet rising demand, the government targets one million metric tons of farmed fish annually by 2030. However, adoption remains low, with only 8.3% of surveyed individuals in Buikwe District (regarded as an aquaculture hotspot) engaged in fish farming. High feed costs, accounting for up to 70% of production expenses, remain a key barrier for small-scale farmers.

his study explored alternative protein sources for affordable, sustainable aquaculture along Lake Victoria. A survey of 120 residents in Buikwe District found fishing (42.5%) and crop farming (43.3%) to be dominant, with informal fisheries-linked activities also common but increasingly vulnerable due to declining catches. Despite their potential, no respondents practiced Black Soldier Fly (BSF), spirulina, or cricket farming. Yet, BSF larvae can yield 500 kg per ton of organic waste and cut feed costs by up to 40%, with a one-hectare farm producing five tons monthly—enough for 10–15 tons of fish. Spirulina (20 g/L/day) and crickets, with high feed efficiency, offer equally scalable, protein-rich alternatives. Accordingly, integrating insect and algae farming into extension services, establishing community demonstration farms, and linking value chains to finance and nutrition programs (especially for women and youth) could accelerate adoption. Aligning training, policy, and investment is crucial to achieving national aquaculture goals while building resilient, inclusive rural economies.

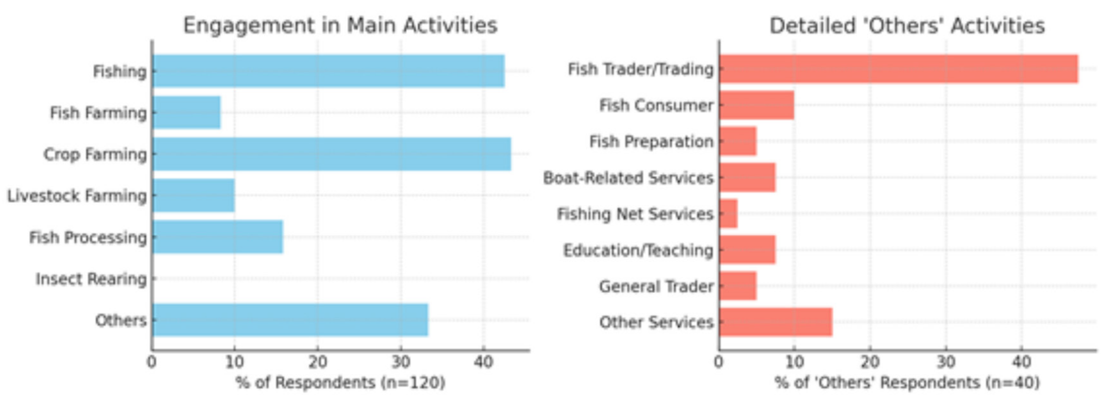

Figure: Livelihood activities in Buikwe District, Uganda — Primary engagements and informal roles supporting the fisheries value chain

ENHANCING COMMUNITY NUTRITION AND LIVELIHOODS THROUGH AQUACULTURE BUSINESS DEVELOPMENT: A CASE STUDY OF ABDP INTERVENTIONS IN 15 COUNTIES OF CENTRAL AND WESTERN KENYA

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This study assesses the impact of the Aquaculture Business Development Programme (ABDP) on nutrition and livelihoods in 15 counties across Central and Western Kenya. Through a gender-responsive and nutrition-sensitive approach, ABDP interventions significantly improved fish production, income, and dietary outcomes. Participation was predominantly male (67.5%), with older age groups more engaged in aquaculture. Treated counties recorded significantly higher household food expenditure ($p < 0.005$) and dam aquaculture yields ($p = 0.003$), with a moderate correlation between production and income. Notably, households in treated areas achieved higher dietary diversity ($p < 0.005$), with women meeting Minimum Dietary Diversity for Women (MDD-W) increasing from 63% to 76.5% ($p = 0.004$). Micronutrient intake improved, particularly for Vitamin A-rich foods. Schools supported through ABDP showed higher fish productivity and increased access among pupils ($p = 0.002$). Community-led nutrition initiatives, such as kitchen gardens and cooking demonstrations, complemented these gains. A strong positive correlation ($r = 0.612$, $p = 0.002$) was observed between fish consumption and the number of Social and Behavior Change Communication (SBCC) Fish Faires conducted. Overall, ABDP demonstrated measurable success in leveraging aquaculture for rural food security, income generation, and improved community nutrition.

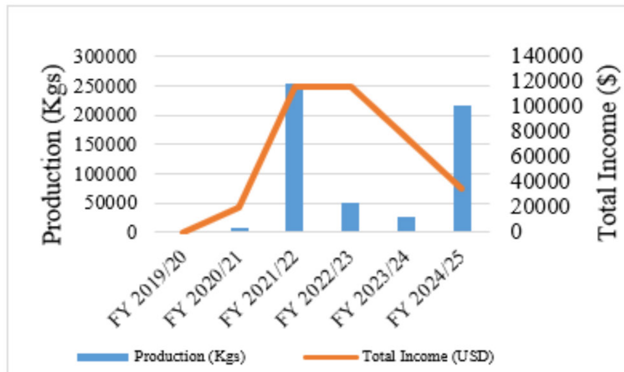

Figure 1: Changes in Dam Aquaculture Production and Income

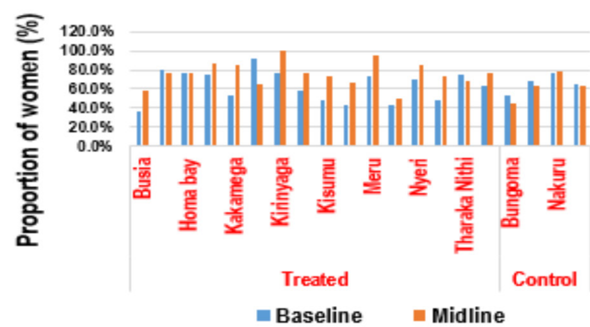

Figure 2: Proportion of Women Meeting MDDW of 5

Table 1: Fish consumption and correlation with SBCC interventions

Indicator	FY 21–22	FY 22–23	FY 23–24	Test Statistic
Quantity of Fish Consumed (Kgs)	638.2 ± 661.5	750.4 ± 983.1	321.7 ± 505.2	$F(2,28) = 5.67$
Sub-total Outreach (attendees)	548.7 ± 617.9	674.2 ± 879.1	817.6 ± 1185.4	$F(2,28) = 3.45$
Youth Outreach (attendees)	142.2 ± 145.8	215.1 ± 284.2	219.3 ± 326.8	$F(2,28) = 2.87$
PwDs Reached	11.3 ± 16.8	8.1 ± 12.4	9.9 ± 16.2	$\chi^2(2) = 1.45$
Correlation between SBCC events and Fish Consumed	–	–	–	$r = 0.612$

EXPLORING GOVERNANCE DYNAMICS IN THE AQUACULTURE SECTORS IN UGANDA AND ZAMBIA USING THE AQUACULTURE GOVERNANCE INDICATORS (AGI) FRAMEWORK

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Uganda and Zambia are two of the largest aquaculture producers in sub–Saharan Africa with remarkable growth attributed to a private sector led industry. However, current aquaculture production does not meet the national and regional demand for food fish. Moreover, there is a widening gap between small scale and large-scale producers, resulting in unequal distribution of benefits within the sector. Governance is a pivotal transformer for aquaculture's growth but there is limited information on Africa's landscape. Therefore, this study assessed the political, institutional, collaborative arrangements /partnerships, and regulatory dimensions that have contributed to the transformation of Uganda and Zambia's Aquaculture sector using Aquaculture Governance Indicators (AGI) framework.

Preliminary analysis revealed that Uganda has strong legislative framework covering major industry and environmental issue areas including effects of aquaculture effluent on the environment, habitat, chemical use, source of stock disease and escapees. However, it needs to be; i) strengthened at National and local levels ii) efficiently coordinated and enforced, and iii) extension support strengthened to increase compliance for small scale farmers. In the case of Zambia, the legislation is currently being revised to include aspects of aquaculture however, there is the National Fisheries and Aquaculture policy and implementation plan that address key industry and environmental issues like disease, climate change and environmental degradation. The use of market-based governance mechanisms such as private standards is limited and generally perceived to be applicable to large scale commercial farms targeting international export of farmed fish. The key collaborative processes vary and include industry-led (Commercial Fish Farmers Associations), multistakeholder platforms or donor funded projects implemented by government ministries or research institutions in collaboration with market and civil society actors. Governance and partnership arrangements are deemed very relevant to address the main industry issue areas. However, there is need to: i) enhance the visibility of their deliberative processes, ii) strengthen coordination and learning processes within and between collaborative arrangements. This study provides insights to foster learning, better understanding of the challenges within the sector and a starting point for engagement among different stakeholders around identified gaps to ensure sustainable development.

AQUACULTURE: PROSPECTS AND CHALLENGES IN MADAGASCAR

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More than 40 percent of the world population cannot afford a healthy diet. Responding to escalating population growth, Madagascar must address the challenge of feeding its population sustainably, producing high-value commodities for exports while preserving its high biodiversity ecosystems.

Aquaculture is emerging as a crucial sector to meet these needs, offering an opportunity to supply healthy food to the local population and contribute to economic development through niche export markets such as farmed shrimp, seaweed, sea cucumbers, and caviar.

The intensification of national aquaculture production has become increasingly imperative, particularly given that the annual fish consumption in Madagascar is currently estimated at 7 kg per capita, well below the African average of 11 kg per capita. By 2030, an additional 142 000tonnes of seafood will be needed to raise the per capita fish consumption, with most of this supply expected to come from aquaculture. There is a high market demand for aquaculture products, particularly freshwater fish such as tilapia and carp. The average selling price of tilapia in urban areas ranges from 3 to 6 EUR per kg, depending on the season, creating strong interest from medium and small-scale farmers. In 2023, official aquaculture production reached over 30,000 tonnes, but projections indicate a decline to two-thirds of that amount in 2024 with producers facing difficult conditions exacerbated by erratic rainfall, cyclones, and rising water temperatures. In addition, the sector's growth is hindered by systemic constraints, such as limited access to affordable fish feed and market access challenges.

In line with the government's General State Policy, the Ministry of Fisheries and Blue Economy (MEPB) is establishing 19 Zones d'Émergence Piscicoles (ZEP or Fish Farming Emergence Zones) across the country. These zones are equipped with facilities to support private sector production of over 5 million fingerlings annually. This initiative is expected to stimulate local aquaculture, particularly in tilapia and common carp farming, which can be carried out on family-run farms under sheds. Alongside the well-established export-oriented aquaculture sector, a new wave of small- and medium-scale farmers is emerging, deploying diverse production systems ranging from rice-fish system to semi-intensive pond aquaculture to meet the growing demand for locally produced fish.

As the sector strives to adapt to increasing climate variability, there is a pressing need to transition from a niche industry to a major component of Madagascar's economy and food system.

ONE SIZE DOESN'T FIT ALL: RETHINKING INTEGRATED TREATMENT STRATEGIES FOR OOMYCETES IN AQUACULTURE

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Oomycetes are a diverse group of fungus-like eukaryotic organisms, many of which are responsible for serious infections in both wild and cultured aquatic animals. Although oomyctes within the order Saprolegniales, such as *Saprolegnia*, *Achlya*, and *Aphanomyces*, may present with similar clinical signs, they differ notably in their pathogenicity, environmental preferences, and responses to antifungal treatments. . These differences have practical consequences for aquaculture, where empirical, broad-spectrum antifungal treatments often fail to resolve infections effectively, leading to economic losses and compromised animal welfare.

In this study, we report the first isolation of *Achlya bisexualis* from ornamental fish in South Africa and characterise the isolate using morphological, physiological, and molecular techniques. The species demonstrated unique growth responses across a temperature gradient, highlighting the need to consider individual species' biology in disease diagnosis and control. When compared to closely related oomycetes, the variability in physiological traits reinforces that not all oomycetes respond uniformly to environmental stressors or treatments.

Accurate species identification improves aquaculture disease management by enabling targeted treatment protocols, avoiding in discriminate medication use, and informing biosecurity strategies. With molecular diagnostics becoming more accessible, routine identification of oomycetes at the species level should be integrated into standard health monitoring procedures. Such an approach not only improves treatment efficacy but also contributes to antimicrobial stewardship and sustainable aquaculture practices.

This study supports a growing body of evidence that emphasises the ecological and pathological diversity of oomycetes. Recognising and addressing species-specific traits is essential for the advancement of effective, evidence-based disease management in aquaculture systems.

IMPACTS OF A SUDDEN TRANSFER IN LOW TEMPERATURE ON WHITELEG-SHRIMP *Penaeus vannamei*'S BEHAVIOUR AND MOULTING CYCLE : A POTENTIAL TRANQUILIZING METHOD TO REDUCE ACTIVITY AND STRESS DURING LABORATORY HANDLING

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As part of the *in vivo* microscopic observation of the moulting stages of *Penaeus vannamei*, it is planned to develop a method for conferring a tranquillizing effect on handled shrimps. This could facilitate handling by temporarily slowing their activity. The study focuses on the tranquillizing potential of a sudden and short-term transfer of *Penaeus vannamei* shrimp to low temperatures. The objective is to identify the ideal temperature range and acclimatization time that would slow down shrimp activity in the short term, while ensuring that the process does not affect the moulting cycle in the long term.

The study is divided into three trials. First, the effect of temperature on shrimp behaviour was highlighted to identify an ideal range. 20 shrimp were used. Each day, a temperature range (18-20°C, 20-22°C, 22-24°C, 24-26°C, 28-30°C) was tested on each batch of 5 shrimp in a test tank. The following parameters were measured during 5 minutes : average swimming speed, proportion of time spent in motion, travelled distance, proportion of pool explored and amount of food consumed during the test. Secondly, the effect of the acclimatization time was tested and the definition of a reliable criterion to confirm the tranquillization of the shrimps was carried out. Three temperature ranges were tested (18-20°C, 23-25°C and 28-30°C), for four acclimatization times (20, 40, 60 and 90 minutes). Five shrimp were used. At the end of acclimatization, shrimp were held by hand in the open air for two minutes. The time elapsed before the first tail beat and the number of tail beats were evaluated. The third trial is currently underway. It consists in evaluating the potential impact of the tested method on the moulting cycle of *Penaeus vannamei* by dividing 12 shrimps into 3 batches : no handling, handling twice a day (protocol of the second test) and handling twice a day with exposure to low temperatures. Each day, moults are counted to assess the duration of moulting cycles. Growth of each batch is assessed as well as individual feed consumption. A rotation of the batches will allow 36 repetitions. The analysis of the videos was performed via AnimalTA software and the statistical analysis of the data via RStudio.

Regarding the first test, there are significant differences ($p < 0.05$) for each parameter studied between the two extreme temperature ranges (18-20°C and 28-30°C). This validates a calming effect of low temperatures on the behavior of *Penaeus vannamei*. For the second test, we observed a significant difference ($p < 0.05$) between the 18-20°C and 28-30°C ranges for the acclimatization time of 60 minutes for the two parameters observed (time before the first tail beat and number of tail beats). This combination of modalities would then be the best among those tested and would allow a significant decrease in the activity of shrimps handled during microscopic observation of moult stages. The combination of the temperature range 18-20°C with the acclimatization time of 20 minutes also seems interesting in that it allows a great reduction of the acclimatization time. The implementation of the method of tranquillization at low temperatures will thus be possible if the results of the last test allow us to affirm that it has no long-term effect on the moulting cycle of *Penaeus vannamei*.

DEVELOPMENT OF AN ARTIFICIAL INTELLIGENCE TOOL FOR TRACKING AND ANALYSING *Penaeus vannamei* MOVEMENT AND ATTRACTIVITY TESTS ON AFRICAN RAW MATERIALS

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The attractivity assessment of raw materials on *Penaeus vannamei* is carried out to evaluate their potential to stimulate feeding behavior and improve feed intake. This helps optimize feed formulation. To achieve this, an artifical intelligence tool was developped in order to track and analyze *P. vannamei* movement facing different African raw materials.

As a first step, five shrimp are placed in an attractivity measurement tank above which a camera is placed to record them during 5 minutes (figure 1).

The four different raw materials studied are : fermented soy, soy beans, soy cake and toasted cowpea.

The different variables analyzed are : latency time, total distance and speed until reaching the feeding are, number of times the shrimp entered the feeding area and time spent in the feeding area, number of shrimp in the feeding area, time spent in movement, exploration percentage.

The different results obtained show that 67% of the shrimp entered the feeding area for fermented soy and soy cake against 73% for soybeans and toasted cowpea.

No significant differences are observed for the time spent in the feeding area and the number of time shrimp entered the feeding area. Regarding the area, only the speed until reaching it shows a signifiance difference between fermented soy and soybeans with a median value of 3.77 cm/sec and 5.31 cm/sec respectively. This difference is also observed for the time spent moving with 107.29 sec and 184.76 sec respectively. Heatmaps are produced per video for an individual or the whole group.

The Artificial Intelligence tool shows a good capacity of detecting and tracking shrimp movement in the attractivity measurement tank despite the complexity of their behavior and the disturbing elements : individuals overlapping, tail flip, disappearance and camera reflection. This performance enhance the assessment of shrimp feeding behavior.

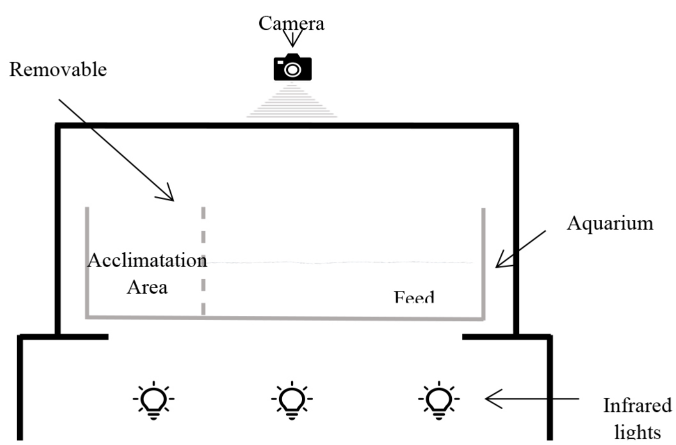

Fig. 1 : Drawing of the attractivity measurement tank

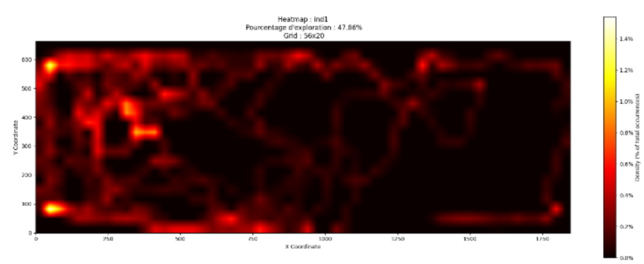

Fig. 2 : Heatmap showing the explored areas for an individual with the fermented soy

BEHAVIOURAL AND GROWTH RESPONSES OF WHITE-LEGGED SHRIMP (*Penaeus vannamei*) TO VARYING RATIOS OF BREWERY SPENT GRAIN (BSG) AND YEAST (BSY) WITH OR WITHOUT BSG SPONTANEOUS FERMENTATION

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Introduction

The cost and availability of protein-rich ingredients is a challenge for the development of the fish feed sector, especially in developing areas. As a result, alternative protein sources are being used, such as brewery spent grains (BSG) and yeast (BSY). As agro-industrial by products, they do not contribute to competition for land and resources with human feed or other animal feed productions. The high-water content (75-85%) of BSG when exiting the brewery limits its use in sub-Saharan Africa due to the heterogenous mastering of drying process in factories. Then, spontaneous fermentation as a low-cost conservation method seems to be an interesting alternative. BSY have been studied most often for their role in boosting immunity. However, their interest as a palatability, attractiveness, or growth enhancer remains little studied. Therefore, these trials aims to determine whether the fermentation state of BSG influences feeding behaviour and growth of shrimp depending on the BSY/BSG ratio.

Material & methods

The behavioural trial aims to study whether feed attractivity and palatability are influenced by the state of fermentation of BSG and by the ratio BSG/BSY following a factorial design described in table 1. 35 shrimp will be distributed in 7, 50L reserve tanks with 5 shrimp per tank. 7 isoproteic experimental feeds containing a neutral base and 15% of BSG and BSY mixture will be manufactured. During 5 days, groups of five shrimp will be presented the different feeds in a tank dedicated to behavioural studies equipped with cameras. Each group is only presented to a feed once a day and is never presented to the same feed twice. Prehension speed, time spent in feeding zone, shrimp activity and feed consumption will be monitored through video tracking (using an AI based model) and statistically analysed.

The growth trial will be conducted over 42 days. 525 juvenile shrimp will be distributed in 35, 50L independent tanks with 15 shrimp per tank. Tanks will be randomly divided into 7 groups with 5 tank per group as described in table 1. The 7 experimental feeds will be isoproteic and isolipidic (36.6% proteins, 7.3% lipids) containing 15% of the BSG and BSY mixtures. At the end of the trial, growth performances will be analysed via statistical analysis.

Objectives

Experiments assessing ingredient attractivity and palatability took place in April 2025. The growth trial started the end of April 2025 and will end in June 2025. These experiments will help to fill the data gap while providing information on the interest of BSG and BSY for aquafeed.

Table 1. Behavioural and growth trials factorial design

	Non fermented BSG	Fermented BSG
90% BSG / 10% BSY	r=5	r=5
70% BSG / 30% BSY	r=5	r=5
50% BSG / 50% BSY	r=5	r=5

Control
r=5

DEVELOPING EFFECTIVE VACCINES FOR TILAPIA: A CASE STUDY IN STREPTOCOCCOSIS PREVENTION

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As tilapia farming expands globally, infectious diseases continue to challenge sustainable production. Vaccination has emerged as one of the most effective tools to prevent disease outbreaks, reduce antibiotic use, and support fish welfare. The development of vaccines for tilapia requires a tailored approach, considering species-specific immune response, pathogen diversity across regions, and practical administration methods in farm conditions.

This presentation outlines the key stages in fish vaccine development—from pathogen identification and antigen design to efficacy and safety validation under both laboratory and field conditions—within the required regulatory framework. As a case example, we present data from ALPHA JECT micro 1 TiLa, an inactivated vaccine against *Streptococcus agalactiae* serotype Ib. Laboratory trials using isolates from Latin America and Asia has proved high levels of protection, and field evaluation confirmed safety and efficacy under commercial conditions.

WHAT BARRIERS DETER DEVELOPING COUNTRIES' YOUTH FROM PARTICIPATING IN FISH FARMING? EVIDENCE FROM CENTRAL MALAWI

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Youth engagement in fish farming offers numerous societal advantages in developing countries, including economic empowerment, improved food and nutrition security, enhanced social inclusion, reduced rural-to-urban migration, and the promotion of environmentally sustainable livelihoods. Despite these substantial benefits, youth participation in aquaculture remains low, raising concerns about underutilizing this sector's transformative potential. This study investigates the limited engagement of youth in fish farming by examining the entry barriers they face, focusing on the production of *Oreochromis karongae* (commonly known as Chambo), a high-value fish species in Malawi. Fieldwork was conducted in Dowa and Mchinji districts between January and February 2022. A total of 102 youth fish farmers were selected using a multi-stage sampling technique. Data were analyzed using descriptive statistics and a probit regression model to identify determinants of participation. Results indicated that youth in aquaculture were predominantly reliant on agriculture for livelihoods and had relatively low education levels. Key participation factors included household size, access to extension services, land ownership, membership in farmer groups, and prior training. Major barriers were identified as limited access to capital and credit, high feed costs, scarce quality fingerlings, and inconsistent policy support. The study recommends targeted capacity-building, financial inclusion, and youth integration into aquaculture value chains.

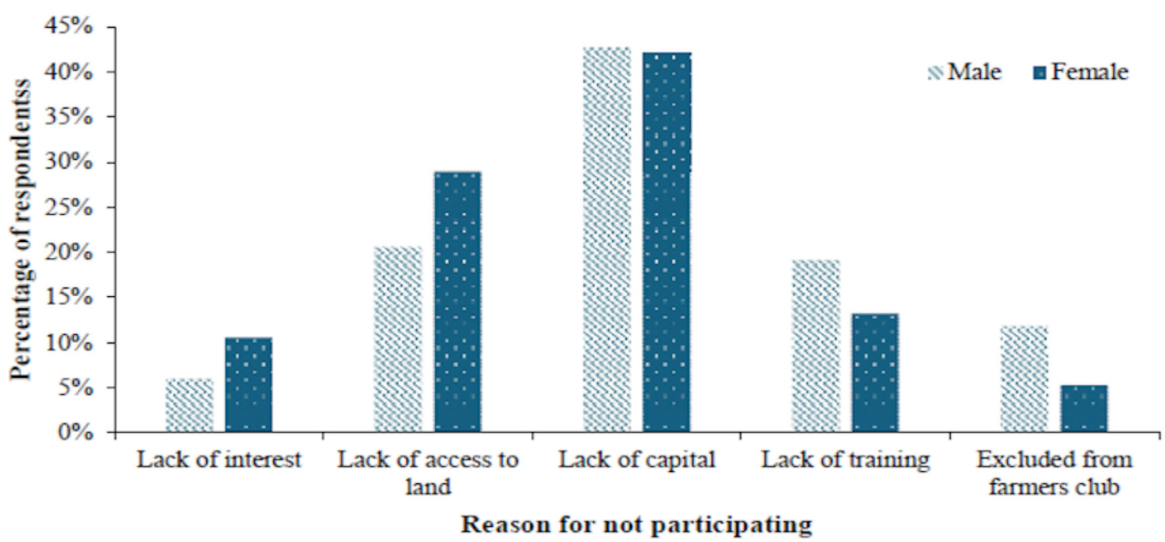

Figure: Perceived reasons for not participating in fish production based on the sex of youths from Central Malawi.

SOCIAL LICENSE AND ACCESS IN AQUACULTURE: DOCUMENTING PERCEPTIONS OF NUTRITIONAL, ECONOMIC, AND ENVIRONMENTAL RISKS AND BENEFITS IN LAKE VICTORIA'S

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Aquaculture is increasingly promoted as a strategy for enhancing global food security, fostering economic development, and supporting fishery sustainability. However, its rapid growth has outpaced both research and the establishment of governance frameworks that balance industry expansion with the need to mitigate social and ecological risks. Inequities in who gains from aquaculture and who bears its social and environmental costs can undermine local support and long-term sustainability and recent findings suggest that different farm types may have variable social and ecological risks and benefits to local communities. Given large growth of the aquaculture sector in Lake Victoria, we aim to use a mixed-methods approach to understand the livelihood and food security impacts of aquaculture for fish farm workers and local community members and explore local perceptions of aquaculture governance mechanisms and impacts on the environment and local communities. We will also identify farm characteristics that lead to positive livelihood outcomes for local community members in Uganda. Key informant interviews will be conducted with managers and owners at fish farms and community leaders of fishing communities, and household surveys will be conducted with farm workers and community members who reside near and far away from aquaculture sites. We predict that farm workers will exhibit higher food security and higher dietary and livelihood diversity scores compared to local communities, but that households near aquaculture will demonstrate higher food security and dietary and livelihood diversity compared to those farther away from aquaculture sites. We also predict that perceived negative impacts of the industry will be greater for local communities compared to farm workers, while perceived positive impacts of the industry will be greater for farm workers. Additionally, we predict that large-scale producers that had high community engagement, local hiring and fish selling programs, strong environmental management efforts, and fair wages for employees will contribute to higher food security and dietary diversity for farm workers and local communities. As aquaculture continues to be the focus of global food security, further research on identifying ways in which the sector can positively impact livelihoods and nutrition will be invaluable. We hope the findings of this study can inform sustainable approaches to aquaculture governance in Lake Victoria.

EFFECTS OF NILE TILAPIA FISH CAGE FARMING ON MACROINVERTEBRATES COMMUNITIES IN LAKE KIVU, BUKAVU SUB-BASIN, DEMOCRATIC REPUBLIC OF THE CONGO

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In this study, we analysed how macroinvertebrates communities at two cage stations (Ndendere and Honga) in the Bukavu sub-basin in Lake Kivu, respond to Nile tilapia cage farming activities, while Nyofu station was used as the control. Ndendere and Honga stations had cage farming activities running under their belt for more than a year while the control station Nyofu, lacked cage culture activities. Macroinvertebrates specimens were collected for six months and in two seasons, wet and dry. Physico-chemical variables were measured in situ using portable probes. Water samples collected were analysed for some nutrients and Chlorophyll-a, in the laboratory. Turbidity, water transparency, DO and PO_4^{3-} were significantly different between the stations ($p<0.005$). A total of 3938 macroinvertebrates individuals were collected. Three phyla (Arthropoda, Mollusca and Annelida), nine orders (Gastropoda, Diptera, Decapoda, Annelida, Odonata, Ephemeroptera, Coleoptera, Heteroptera and Hemiptera) and 37 families were identified. The composition of macroinvertebrates communities significantly differed ($p=0.00$) between the stations. Temporally, only little variation was observed in abundance between the seasons. Three same and abundant groups including Diptera, Gastropoda and Odonata dominated the two caged stations (Ndendere and Honga) and the control (Nyofu) station. The findings of this study show that with small variations but no significant differences observed in macroinvertebrates communities and water quality among stations, cage farming is not yet a threat to the Lake Kivu's ecological condition. The study therefore recommends that more frequent monitoring on macroinvertebrates and water quality to be done for sustainability of the lake's ecological functioning.

GENDER–SPECIFIC VALUE CHAIN ANALYSIS AND MAPPING STUDY IN SMALL SCALE FISHERIES LAKE VICTORIA: A FOCUS ON ROLES AND OPPORTUNITIES

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The Dagaa Gendered Value Chain Analysis conducted in Lake Victoria, Tanzania, focuses on small-scale fisheries and the pivotal role women play in the dagaa value chain. This study offers critical insights into the post-harvest sector where women are predominantly involved, exploring the structural and gender-specific challenges they face, while identifying opportunities for improvement and empowerment.

Women are integral to fish processing and trade, yet they encounter significant constraints, such as limited access to credit, land ownership, market information, and decision-making authority. The analysis revealed that only 42% of women's groups in Musoma and 66% in Muleba districts are formally registered, limiting their access to resources and legal protections. Moreover, women-owned businesses often struggle due to a lack of soft loans and financial services, with only 11% of groups in Musoma reporting access to such funds.

Furthermore, gender-based constraints in the value chain are driven by traditional cultural practices that limit women's roles in decision-making processes. These barriers extend to labour dynamics, where women are marginalized in male-dominated fishing operations, and even within processing activities, women are often confined to lower-paying, physically demanding tasks with minimal support.

Despite these challenges, the study identifies key opportunities for strengthening women's involvement in the value chain, including enhanced infrastructure, financial access, and market linkages. Through targeted support such as access to improved drying spaces, market information platforms, and financial literacy programs, establish of processing centers, the productivity and economic empowerment of women in the fisheries sector can be significantly enhanced.

In conclusion, the report underscores the urgent need for policies that promote gender equality in fisheries, especially within the dagaa value chain. Implementing supportive structures and eliminating discriminatory practices will not only boost women's economic independence but also enhance the sustainability of the fisheries sector in Tanzania. The findings and recommendations aim to foster a more equitable and prosperous future for women in fisheries, aligning with national and regional development goals.

BIOFLOC TECHNOLOGY IN AQUACULTURE: MAXIMIZING NUTRIENT UTILIZATION WITH NILE TILAPIA AND FILTER FEEDERS

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Biofloc technology (BFT) is an environmentally sustainable aquafeed and an innovative ecological farming technique used to reduce nitrogen concentrations and pollutants from aquaculture. This study investigates the use of biofloc nitrogen by tilapia (*Oreochromis niloticus*), integrated with freshwater mussel (*Coelatura cridlandi*) in a biofloc system. Biofloc was prepared using brown sugar as an additional carbon source (33% carbon) in a concrete fish pond (25m^3), maintaining a C/N ratio of 20 and a total suspended solid concentration of 250 mg L^{-1}. The experiment, carried out in 400L tanks, tracked the dynamics with biofloc as the sole feed source for 30 days. Key water quality parameters such as total ammonia nitrogen (TAN), nitrate (NO_3^--N), nitrite (NO_2^--N), pH, temperature, dissolved oxygen, and salinity were monitored. The results indicated that the TAN concentrations were significantly lower in the treatment tanks after 15 days ($P<0.05$). A total of 47 species of microalgae were identified, with the highest number of potential microalgae (Bacillariophyta and Chlorophyta) observed in the treatment groups. The study also showed significantly lower concentrations of Vibrio-like bacteria (VLB) in biofloc treatments compared to the control ($P<0.05$). The results suggest that the quality of the water improved significantly due to the substantial consumption of biofloc by tilapia in the integrated treatment with both tilapia and mussels. High nitrogen uptake values indicate that tilapia can efficiently use biofloc for growth, providing a promising theoretical foundation for future research on freshwater polyculture models.

Table 1 Mean and standard deviation (n = 5) in the biofloc system.

	Treatment			
Parameters	Control	BFT1	BFT2	BFT3
NO_2^--N	1.93 ±0.55	0.29±0.08	0.17±0.01	0.16±0.03
TAN	1.87±0.70	0.57±0.34	0.50 ±0.20	0.18±0.23
PO_4^{3-}-P	1.49 ±0.58	0.18±0.03	0.23±0.93	0.35±0.10
NO_3^--N	1.45 ±0.13	0.51±0.05	0.15±0.77	0.59±0.56
TP	4.06 ±1.15	0.47±0.19	1.41±0.34	1.10±1.49
TN	4.50 ±1.55	1.74±0.26	10.16±2.60	1.88±0.27
COD	18.01±2.87	15.59±6.21	14.81±4.61	11.39±5.0
WT	29.08±0.24	23.93±0.17	25.43±2.13	27.27±1.26
DO	4.67 ± 0.17	7.64±0.15	9.15±0.36	6.26±1.44
pH	7.28 ± 0.27	8.61±0.08	7.99±32.09	7.45±0.35
chl α	23.87 ±8.51	33.35±13.03	42.09±16.61	52.70±2.7

EMPOWERING INDIGENOUS COMMUNITIES, YOUTH AND WOMEN IN AQUACULTURE: INNOVATIVE APPROACHES FOR SUSTAINABLE LIVELIHOODS AND FOOD SECURITY IN TANZANIA

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Small-scale fishing communities play a crucial role in managing aquatic resources supporting livelihoods, food security and nutrition. However, their marginalization hinders agricultural development and exacerbates socio-economic vulnerabilities. In the aquatic sector, inclusive development efforts should involve diverse stakeholders, particularly indigenous fishing communities, who possess valuable local knowledge that can contribute to technology innovation and environmental conservation for sustainable fisheries development.

The eco-innovative technologies for improved nutrition, sustainable production, and marketing of agroecological food products in Africa (INNOECOFOOD) project conducted a baseline study employing the use of focus group discussions with over 60 participants from six different groups in Magu District, Tanzania. The discussion was on fish, spirulina and insects farming, processing and consumption. Findings reveal that Lake Victoria's fishing communities still rely on capture fisheries due to limited capital and insufficient technical expertise in modern, climate-smart aquaculture technologies. Despite these barriers, over 80% of respondents showed a willingness to adopt climate-smart technologies. Declining fish stocks continue to threaten livelihoods, increasing socio-economic and food security risks. Strengthening local capacity in innovative fish production and processing will promote an inclusive fish value chain, improving food security and climate resilience. Youth and women, in particular, will be empowered to participate in and influence the fish value chain.

A local business hub (Ecohub) in Chabula, Magu district is under construction, equipped with state-of-the art technology for water and energy provision and AI and IoT technology for sustainable aquaculture (fish and spirulina) and insect farming. The Ecohub will provide training in recirculating aquaculture systems (RAS), spirulina farming, waste upcycling, and value addition. Infrastructure such as grow-out ponds, solar dryers, and ice-making machines will enhance sustainable aquaculture and climate-resilient livelihoods.

COMPARATIVE STUDY OF PARASITIC INFESTATION OF POND AND CAGE CULTURED NILE TILAPIA *Oreochromis niloticus* IN THE LAKE VICTORIA CRESCENT, UGANDA

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Background

- Aquaculture intensification has led to increased parasitic disease occurrences
- Despite efforts, parasite burden has continued.
- Culture systems provide different habitats and environmental conditions to fish parasites.
- Understanding parasitic infestation dynamics in these systems may provide better sanitary and farm management strategies.

Materials and methods

- 18 Pond grow-out, 9 Cage grow-out (lake), 2 Cage grow-out (reservoir) & 2 Hatchery farms visited
- 640 Nile tilapia examined for parasites
- Farm management data collected

Statistical analysis

- **Infestation levels**- Prevalence (P), Mean intensity (Mi) & Mean abundance (Ma)
- **Comparison of Prevalence** (P) in culture systems-Chi-square test of association
- **Relationship between Parasitic Infestation & Farm Management**-Fisher's Exact Test

Results

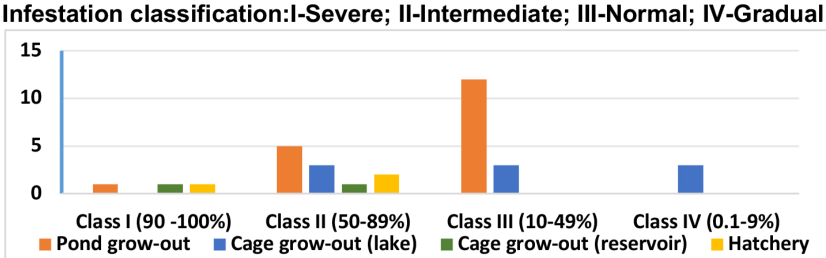
Infestation levels / **% prevalence**

No.	Genus	P(%)	Mi	Ma	Pond	Cage lake	Cage reser	Hatchery
1.	*Trichodina*	23.4	41.21	9.66	23.9	17.2	45	25
2.	*Dactylogyrus*	14.2	4.16	0.59	12.2	16.7	20	15
3.	*Neascus*	5.6	4.9	0.28	5.5	3.9		15
4.	*Clinostomum*	3.6	3.22	0.12	3.9	1.1		11.7
5.	*Ergasilus*	5.9	4.61	0.27	4.2			38.3
6.	*Myxobolus*	4.4	13.64	0.60	2.5		12.5	23.3
7.	*Amirthalingamia*	0.6	2.25	0.014	0.3			5
8.	*Acanthocephalus*	1.4	1.56	0.022				15
9.	*Monobothroides*	0.2	25	0.039				1.7
10.	*Contracaecum*	0.3	3	0.0094	0.6			
11.	*Eimeria*	0.2	35	0.055				1.7
12.	*Gyrodactylus*	0.6	4.5	0.028				6.7
13.	*Chilodonella*	0.3	17.5	0.055	0.6			
14.	*Ichthyobodo*	1.9	6	0.11	3	0.6		
15.	*Ambiphrya*	0.3	12	0.038	0.6			
16.	*Diphyllobothrium*	3	11.47	0.34	5.3			

Association between parasite prevalence & farm management

	Pond	Cage lake
Parameter	*p*-Value	*p*-Value
Seed source	0.022*	1
Stocking density	0.013*	0.04*
Feeding	0.009 *	0.01*
Disinfection	0.04 *	1
Control of intermedite hosts	0.0 *	1
Control of wild fish entry	0.02*	0.04*

Infestation classification:I-Severe; II-Intermediate; III-Normal; IV-Gradual



Discussion & conclusion

- Infestation rate of 65% (418/640) > Akol et al. (2011)
- *Trichodina*-most prevalent & abundant→Akol et al. (2011)→**Poor water quality**
- ≥11 parasite genera in Pond & Hatchery; ≤5 genera in Cage (lake) & Cage (reservoir)→ **Land based systems favour parasites more.**
- Higher infestation in Pond than in Cage (lake) was associated with all management→
- **Poor management increases parasite burden**

WORLD BANK SPECIAL DAY – PRESENTING TWO REPORTS FOR OPPORTUNITIES IN AQUAFEEDS, AND ENVIRONMENTAL AND SOCIETAL CO-BENEFITS

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This presentation highlights the two World Bank Group reports prepared by The Nature Conservancy and The center for Responsible Seafood, 1) Opportunities for expanding aquaculture using ecofriendly aquafeeds in the Global South - An analysis of feed materials and opportunities for sustainability with innovative ingredients and 2) Case studies of investment and design of integrated aquaculture into land and seascapes - An evaluation of payment for ecosystem services, biodiversity enhancement, economics, and scalability of integrated and restorative aquaculture.

The first report is a collation of analyses and case studies to provide practical examples of economic values, societal benefits, and ecosystem services associated with restorative, extractive, or non-fed aquaculture integrated into land and seascapes. The case studies report will help in the process of making informed decisions, develop effective project strategies, and contribute to the improvement of food security, nutrition, job creation, climate change mitigation, biodiversity enhancement, and other economic, social, and environmental benefits within their respective aquaculture projects.

The second report collates examples and analyses describing opportunities to couple aquaculture activities with the provision of environmental and societal co-benefits; benefits that are associated with the primary activity of aquaculture to provide food or revenue. These case studies include: seaweed aquaculture in Sri Lanka, oyster aquaculture in Senegal, and integrated aquaculture-agriculture in Guinea, paired with insights and lessons that could be learned from established sectors in other countries, namely seaweed farming in Tanzania and climate-adapted approaches to seaweed aquaculture in Belize, oyster aquaculture in Vietnam, and integrated shrimp aquaculture systems for climate-smart outcomes in Indonesia and Ecuador.

HOW CHANGES IN GLOBAL SUSTAINABILITY EXPECTATIONS MIGHT AFFECT AQUACULTURE OPERATIONS IN THE BOARD ROOM AND ON THE FARM – CHALLENGES AND OPPORTUNITIES

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In this presentation, I'll discuss both the opportunities and challenges that sustainability expectations and reporting bring to aquaculture development, both new and existing operations. I'll explore the origins of these reporting expectations, why sustainability should be viewed through an environmental, social, and governance (ESG) lens, and how ESG reporting might provide benefits. I'll also highlight the opportunities in initiatives like Integrated Multi-Trophic Aquaculture (IMTA) and circular economy strategies, which could attract Blue Finance. Finally, I'll suggest ways to build stronger, more sustainable relationships and provide some ideas that might help small businesses and farmers do better in sustainability reporting and management.

FINGERLING DELIVERY AND HATCHERY PRODUCTION TO SUPPORT SME AQUACULTURE

Enos MacWere

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The success of commercial aquaculture in Africa has largely focused around the growth of large, internationally-invested, vertically integrated companies. But for aquaculture to fulfil its potential there needs to be strong development of small and medium enterprises (SMEs), both at the farm and through service provision. We must practice African aquaculture with a big contest of ideas, devoid of “there is us (stagnating) and there is them”.

A critical part of the supply chain is fingerling supply. Governments and international donors have spent millions of dollars trying to kickstart smallholder aquaculture industries in many African countries, but with little lasting success. Diverse commercial sectors in Nigeria and Egypt have grown because of the concentration of producers in specific areas. But how do you grow an industry when the customer (farmer) base is dispersed?

Experience from East Africa shows that you need a mix of opportunities. Being able to supply into some of those donor-funded projects helps hatcheries (and other service providers) to survive. Sporadic supplies to vertically integrated farms, when they have production limitations, is also useful business. But hatcheries need a diverse customer base that demands product throughout the year. The growth of several independent, medium-scale cage operations has created a meaningful market. Some ponds farmers are now regularly demanding fingerlings. The development of distribution networks provides additional business opportunities and gives smaller-scale producers confidence that fingerlings will be available more easily and at competitive prices. Has the industry now reached a scale and diversity that can sustain commercial hatchery and fingerling distribution businesses?

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CURRENT STATUS OF AQUACULTURE IN TANZANIA

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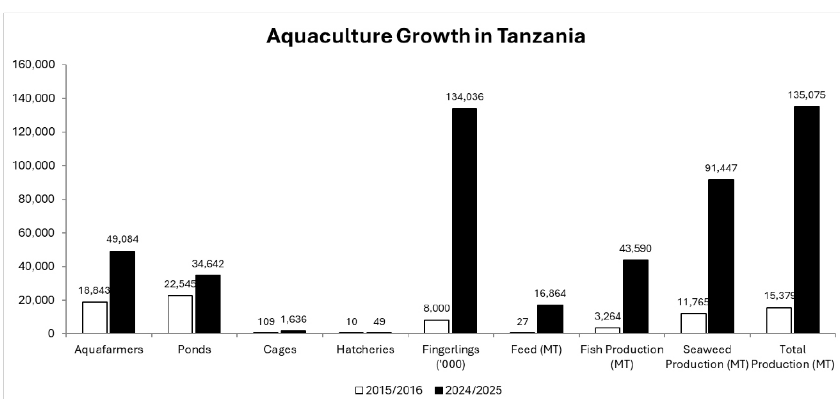
Aquatic food systems play important role in Tanzania providing direct and indirect employment to over 6 million people, contributing 1.7% of GDP and 30% of animal protein intake. In 2025, combined fish production from both capture fisheries and aquaculture was about 510,000 metric tons falling short to meet is current demand estimated at 715,606.5 metric tons. Aquaculture contributing 8.5% is poised to play a greater role to support aquatic food systems given the dwindling fish catch from capture fisheries and the abundance aquatic resources both marine and inland. There is policy, regulatory and institutional frameworks to guide and govern the aquaculture industry including the National Fisheries Policy of 2015, The National Blue Economy Policy, Fisheries Sector Master Plan (2021/22–2036/37) and National Aquaculture Development Strategy (2018 – 2025), Fisheries Act of 2003, Fisheries (Aquaculture) Regulations of 2024 and other legislations related to Water, Land, Environment, Animal Feeds and Animal Diseases.

Aquaculture has shown growth for the past ten years with farmed species including tilapia, African catfish, seaweed, marine shrimps, sea cucumber and half pearls. Further growth requires Strengthening institutional capacity to deliver technical and advisory services to increase adoption of better management practices, increasing access to key inputs by supporting private sector investment, increasing access to finance support investment in commercial aquaculture, strengthening cold chain facilities, value addition and market linkages and enhancing education and skills development, generation of knowledge, technologies and innovation as well as their effective sharing to value chain actors.

Government of Tanzania is undertaking several initiatives to address issues identified including establishment of scheme of service for aquaculture officers to strengthen extension services, establishing online portal to simplify application of permits, strengthening capacity of aquaculture development centres and establishment of fish farming field schools to enhance adoption of good aquaculture practices; exemption of value added tax and import duty on selected aquaculture inputs and equipment; establishing aquaculture youth incubators to enhance skills; undertaking zonation for cage fish farming in large water bodies and giving interest free soft loans to stimulate investment in commercial aquaculture. The Government is committed to transform aquaculture into a resilient and vibrant industry to make Tanzania a continental leader in aquaculture.



ADVANCING SUSTAINABLE AQUACULTURE: IMPLEMENTATION STATUS OF THE PROFISHBLUE PROJECT IN TANZANIA

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Tanzania is making significant strides in advancing sustainable aquaculture through the PROFISHBLUE Project (2022–2025) under the Southern African Development Community (SADC) framework, with support from the African Development Bank. This initiative is a pivotal contribution to the blue growth agenda, emphasizing sustainable fisheries management to bolster food security, economic resilience, and employment creation while strengthening intra-regional trade. With an integrated approach, the project enhances governance of shared fisheries and aquaculture resources, productivity, and market access by promoting value addition and empowering small and medium enterprises (SMEs) and cooperatives. Additionally, it prioritizes climate adaptation strategies, equipping fish value chain communities to withstand environmental changes and external shocks. Through regional collaboration, knowledge-sharing platforms, and data-driven decision-making, PROFISHBLUE fosters resilience and innovation. Implemented through a multi-stakeholder partnership, including SADC Member States, WorldFish, ARSO, FAO, UNIDO, and WWF Mozambique, the initiative exemplifies the interconnected objectives of fisheries and aquaculture sustainability, economic advancement, and regional trade integration. Key achievements include infrastructure modernization (refrigerated transport, vessel monitoring systems), governance capacity-building, SME development through exhibitions and e-commerce expansion, and the promotion of aquatic food products. Improved border hygiene facilities and emergency relief funding further safeguard the sector's long-term stability. As Tanzania advances its aquaculture agenda, continued investment in policy harmonization, infrastructure enhancement, and capacity-building remains central to ensuring a lasting impact, reinforcing its role as a regional and global leader in sustainable aquaculture.

DEFINING INTEGRATED MULTI-TROPHIC AQUACULTURE (IMTA) IN KENYA: A SCOPING STUDY

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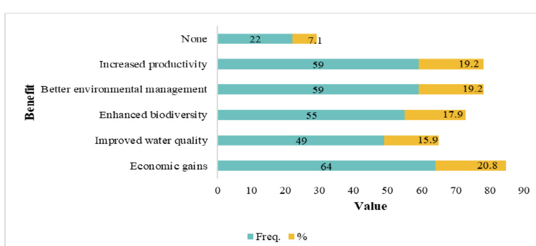
Integrated Multi-Trophic Aquaculture (IMTA) presents a transformative approach to sustainable aquaculture, addressing environmental, economic, and social challenges by integrating species across different trophic levels. To identify gaps and needs, as well as opportunities for improving mariculture in Kenyan coast though IMTA interventions, we conducted a scoping study that consisted of a literature review, structured questionnaires and interviews with key informants and focus groups. This study was done across five coastal counties of Kwale, Mombasa, Kilifi, Tana River and Lamu in Kenya.

The results of the study portray perspectives on awareness and understanding of IMTA in Kenya, the current production prospects from mariculture, stakeholder preferences, opportunities and challenges existing within the sector. From the findings of the study, a roadmap for developing IMTA in Kenya is presented consisting of strategic elements and proposed implementation plan. The study concludes with recommendations for supporting small scale mariculture farmers to adopt IMTA with key interventions being support with training, infrastructure development, inputs, demonstration sites with IMTA designs in form of ponds, cages and pens.

Table: Familiarity with IMTA concept

County	Gender	Not familiar	S.w familiar	V. familiar	N	TWS	WAS	%	Rank
Kilifi	Female	8	27	11	46	95	2.2	72.5	1
	Male	16	16	2	34	54	1.6	52.9	8
Kwale	Female	42	18	2	62	84	1.4	45.1	10
	Male	20	9	9	38	65	2.1	68.2	2
Lamu	Female	3	5	0	8	13	1.6	54.1	7
	Male	11	21	0	32	53	1.7	55.2	6
Mombasa	Female	19	8	0	27	35	1.3	43.2	11
	Male	5	7	0	12	19	1.6	52.7	9
Tana River	Female	2	10	5	17	37	1.8	61.2	4
	Male	6	14	3	23	43	1.9	62.3	3
Average							1.7	56.4	

Benefits observed with IMTA adoption



INVESTIGATING OPPORTUNITIES TO REDUCE PATHOGENS WITH PERIPHYTON IN LAND-BASED RESTORATIVE AQUACULTURE SYSTEMS

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Advances in land-based Marine Aquaponics or Integrated Multi-Trophic Aquaculture (IMTA) systems have been developing over the past ten years. This restorative approach to aquaculture food production incorporates environmental principals and has the potential to produce food, while improving the environment. Expanding the development of environmentally friendly and sustainable aquaculture systems is needed to reduce fishing pressure on declining wild fish populations and meet the growing demand for safe and sustainable seafood. Mote Aquaculture Research Park (Mote) scientists, in partnership with the National Mariculture Center (NMC) in Israel, the University of South Florida's College of Engineering (USF) and Auburn University are evaluating the potential for periphyton biofilms to not only increase water quality, but to enhance the disease resistance and growth of the cultured species.

Fish pathogens are a significant cause of loss and cost in aquaculture. Frequently, pathogens accumulate in high nutrient areas, such as in the microbial community of the nitrifying biofilter in recirculating aquaculture systems (RAS). Previous research at Mote shows that microbial communities of periphyton may help to reduce the number of pathogens in the system, preventing their establishment in the RAS biofilms. Validation of the effect of biofilter combination is necessary to establish where pathogens are residing within the RAS and if periphyton is useful for remediating fish pathogens. Two trials were carried out on two separate 2500 L pilot scale RAS for different biofilter combinations with samples taken over two different time periods per trial. The combinations tested in trials were periphyton only and periphyton in combination with a nitrifying biofilter. Samples were extracted with Qiagen EarthSoil Kits and validated on a Nanopore Nanodrop. High resolution classification of fish pathogens using the hsp70 gene and next generation sequencing was carried out to precisely examine fish pathogens in periphyton biofilters and nitrifying biofilters. Results will be compiled by OTU and into stacked bar charts, then compared for significant differences. Multivariate statistics will be applied to find differences in samples by carrying out Principle Component Analysis, GUSTA ME, Mantel dissimilatory, cluster, and redundancy testing in the R programming environment. The diversity will be analyzed with the alpha, beta, and gamma ecological functions. Picrust2 will be applied to the metagenome to predict microbial functions. The results will show if pathogens are residing in the RAS biofilter and what their role is in the microbial ecology.

COMPARATIVE STUDY OF ECONOMIC EFFICIENCY AND SHELF LIFE OF SMOKED FISH USING IMPROVED FISH PROCESSING TECHNOLOGIES

Malawi Z Makawa, E Kaunda and F Kapute (2019)

Lilongwe University of Agriculture and Natural Resources
Lilongwe

Appropriate fish processing methods are required to reduce fish post-harvest losses and mitigate against climate change impacts which undermines highly the economic growth of the fish business. The Traditional smoking method in Malawi is inefficient economically and leads to rapid losses. The more efficient Ghanaian adapted kiln called FRISMO has not readily been adopted because of its nature which led to the redesigning of a "Modified kiln". This study was conducted to compare shelf life and cost benefit ratios of smoked fish from the FRISMO, the Modified and the Traditional kilns. Sensory analysis, chemical analysis (total volatile basic amines nitrogen (TVB-N) and peroxide value determination were undertaken to assess the level of deterioration of the fish during storage at ambient temperature. Cost benefit analysis was carried out to assess the viability of using each of the three technologies to smoke fish. Findings from the study showed a shorter shelf life for the fish smoked using the Traditional kiln (190 days, 10.33-32.2mgN/100g TVBN, 2.64meq/kg -21.96 meq/kg peroxide) than from FRISMO and Modified kilns (210 days, 10.90-22.4 mgN/100 TVBN, 1.34 meq/kg -13.79 meq/kg peroxide) with high significant difference ($P<0.05$). A higher cost benefit ratio was found in products from the Modified kiln (2.21) compared to the FRISMO (1.82) and the Traditional (1.94) kiln indicating that the Modified kiln is more profitable to use than the other kilns. From the results, it is clear that the FRISMO and Modified kilns are superior with products with higher shelf life and higher profitability and therefore their use should be promoted.

SOUTH AFRICAN NETWORK FOR WOMEN IN FISHERIES AND AQUACULTURE (SANWFA)

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Women in Aquaculture
Promoting and enabling Food Security, poverty reduction and entrepreneurship for South African Women and Youth Enterprises in the Fisheries and Aquaculture Sector.

The SOUTH AFRICAN NETWORK FOR WOMEN IN THE FISHERIES & AQUACULTURE SECTOR (SANWFA) was established to ensure impactful inclusion of women in all aspects of the value chain in fisheries and aquaculture sector within South Africa. The overall objective of the non-profit company is to contribute to improving the welfare, working conditions and income of women in the fisheries and aquaculture sector within South Africa.

At the continental level, the South African Network of Women in the fisheries and aquaculture is anchored to the African Women Fish Processors and Traders Network (AWFISHNET) as a forum through which women could share experiences, build the capacities of its members to adopt best practices, improve the access of women's fish products to local and regional markets, and advocate as one 'One Voice' to leverage their role and contribution to the sector. Membership of AWFISHNET is comprised of national women's fish organisations from all 55 African Union member states with regional chapters in place.

Regionally, the South African Network of Women in the fisheries and aquaculture will be anchored within the Southern African Non-State Actors platform in Fisheries and Aquaculture (SANSAFA) as a regional partners for AWFISHNET in order to enhance communication among members and create linkages with other regional stakeholders for regional trade. SANSAFA was formed in 2018 to provide strategic leadership and coordination of all national and sub-national level non state actors in fisheries and aquaculture in the region. This platform is utilised and fully recognised by the Southern African Development Community (SADC).

The formation of the national chapter SANWFA has been supported by the African Union- Inter-African Bureau for Animal Resources (AU-IBAR) and AUDA-NEPAD Agency in response to the demand driven request from the non-state actors including women responding to the implementation of the *Policy Framework and Reform Strategy for Fisheries and Aquaculture in Africa* advocating for the equitable participation of women among the key strategies for improving the performance of Africa's fisheries sector.

This year SANWFA has embarked on setting up projects on ground level for its members and support existing producers through technical support and training. That has seen SANWFA engaging new partnerships and collaborations. SANWFA is in the final stages of negotiations for establishing an aquaculture project at Molepo Dam in Limpopo in partnership with CMC developers for a smart cities. To date the network has partnered with Future Fish, UK based company, to exchange knowledge and experiences, identify and assess opportunities in the Limpopo province. Also thoroughly engaging the Limpopo Department of Land and Rural Development, Agricultural Colleges and the University of Limpopo in efforts to forge collaborations. A Memorundum of Agreement has since been signed with one of the Agricultural Colleges which allows the 2 parties to exchange information and join hands in providing training for the people of Limpopo across all the genders and background. A few water bodies have been identified for fresh water aquaculture and environmental compliance processes are in the final stages.

The objectives are as follows:
*Launch the Flagship Project and develop its implementation strategy; *Collaboration and cooperation with identified stakeholders to advance and maximize socio-economic gains for women in the sector; *Building and strengthening the capacity of members to effectively participate in the sector and build sustainable enterprises including community-based enterprises.

*Attraction of increased public & private investment in the whole value chain; Youth and people living with disabilities.

EMBRYOGENESIS AND OFFSPRING QUALITY OF THE GIANT AFRICA RIVER PRAWN *Macrobrachium vollenhovenii* AT CONTROLLED TEMPERATURES

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Macrobrachium vollenhovenii (Herklots, 1857), the largest of the indigenous West African Palaemonidae prawns, has a high potential for aquaculture. However the protocol of culture of this species is still under study. Thermal limits are narrower for the early stages of *Macrobrachium* spp and some temperatures may reduce the survival of embryos and juveniles. This present study was therefore undertaken to assess the effect of temperature on embryonic development and offspring quality of *M. vollenhovenii* in order to ascertain the optimum temperature required for embryonic and larval development.

In the phase one experiment, females at stage V of gonadal development incubated their eggs at three experimental temperatures and their embryonic development was evaluated. In phase two, larvae were reared at the respective temperatures for 30 days at a stocking density of 30 larvae per litre of water.

Seven embryonic developmental stages (fertilisation, mitosis, morula, blastula, gastrula, nauplius and larvae) were observed and influenced by temperature. The incubation periods were 19, 14 and 13 days at 26 °C, 28 °C and 30 °C, respectively. A temperature of 30 °C resulted in higher broodstock mortality (33.33%) (Table 1). Offspring quality was significantly different between treatments from day five onwards, with the fastest development at 30 °C followed by 28 °C (Table 2). However, larval survival rate was significantly higher at 26 °C (31.7%) followed by 28 °C (27.6%). A temperature of 28 °C could therefore be recommended as the most favourable for embryonic development and larviculture of *M. vollenhovenii*. These findings will help bridge the knowledge gap with respect to captive breeding and hatchery technology for *M. vollenhovenii*.

Table 1: Performance of female broodstock of *M. vollenhovenii* in the three temperature treatments

Parameters	Treatments		
	T26	T28	T30
Female weight (g)	10.3 ± 0.83 a	9.9 ± 0,16a	11.2 ± 0.85a
GSI	13.37 ±0.12	13.09 ±0.21	13.04 ±0.04
No of larvae/g female	522.74 ± 43.24 a	566.05 ± 41.72 a	412.58 ± 23.45 b
% survival of female	83.33 ± 23.57 a	100 b	66.67 ± 0 c
% abortion of gravid female	16.67 ± 23.57a	0 b	33.33 ± 0 a

Different letters within a row denote significant differences ($p < 0.05$)

Table 2: Larval stage index (LSI) in the three temperature treatments

Parameter	Treatments		
	T26 °C	T28 °C	T30 °C
Larval Stage Index Day5	$1.9{\pm}0.10^{a}$	$2.4{\pm}0.1^{b}$	$2.56{\pm}0.05^{b}$
Larval Stage Index Day10	$2.73{\pm}0.06^{a}$	$3.96{\pm}0.66^{b}$	$4.73{\pm}0.05^{c}$
Larval Stage Index Day15	$3.86{\pm}0.06^{a}$	$4.91{\pm}0.04^{b}$	$5.0{\pm}0^{c}$
Larval Stage Index Day20	$4.66{\pm}0.05^{a}$	$5{\pm}0^{a}$	$5.68{\pm}0.08^{b}$
Larval Stage Index Day25	$5.0{\pm}0^{a}$	$5.63{\pm}0.06^{b}$	$6.10{\pm}0.12^{c}$
Larval Stage Index Day30	$5.18{\pm}0.18^{a}$	$6.27{\pm}0.12^{b}$	$6.78{\pm}0.13^{b}$

Different superscript letters in the same row denote significant differences ($p < 0.05$)

STATUS OF AQUACULTURE IN ZIMBABWE: PAST, PRESENT AND FUTURE

Milton T. Makumbe*, Lorraine K. Salimu, Irene Chihanga, Tinotenda Mangarai, Givious Sisito, Chenjemulene Madzivanyika, and Tafadzwa Maredza

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Zimbabwe's extensive freshwater systems has over 10,000 dams covering 3,910 km² supporting inland fisheries and aquaculture, encompassing a wide range of species and activities including trout, catfish, tilapia, sport fishing, crocodile farming, and ornamental fish farming. These play a significant role in the country's economy and rural livelihoods. The sector supports approximately 48,000 livelihoods, with 4,000 people employed in aquaculture, and 44,000 in inland fisheries. Aquaculture production has increased by 24%, averaging 32,000 MT per annum, with a deliberate shift from fisheries to aquaculture due to the decline in capture fisheries. Zimbabwe aims to transform its fisheries and aquaculture sector into a US$1 billion economy by 2030, with plans to produce at least 14,000 MT of farmed tilapia annually and generate US$22 million in value. National fish production for 2024 was estimated at 31,290 MT. Per capita fish consumption for Zimbabwe is 3.2 kg, and national demand is estimated at 60,000 MT.

The Government of Zimbabwe has implemented initiatives to promote fisheries and aquaculture development, improve food security, and enhance livelihoods of fishing communities through the Presidential Community Fisheries and Presidential Borehole Drilling Schemes, flagship programmes under Rural Development 8.0 (RD 8.0). The strategic drilling of boreholes by the Government of Zimbabwe in every village, with each borehole supporting the establishment of two fish ponds, has proactively introduced climate-proofing technologies to enhance resilience in aquaculture, thereby boosting fish production and food security. Combined, these programmes aim to help substitute imports, generate exports, create employment, and increase household incomes. Under RD 8.0, 4,163 fish ponds have been stocked in the last 2 years, with youth, women, and pensioners being major beneficiaries. Youth accounted for 4,490 participants in aquaculture programs in 2024, with a balanced gender representation of 2,490 males and 2,000 females.

However, challenges persist, including limited access to quality fingerlings and feed, high production costs, and inadequate legal frameworks. To address these challenges, the government has also introduced initiatives such as fingerling hubs to improve access to quality fingerlings. Establishment of fish breeding sites is also on-going across the country. The project aims to address the high demand and low supply of quality fingerlings by establishing five government breeding sites in different parts of the country and distributing genetically selected high-performance fish seed. With regards to feed production, different protein source alternatives including insect protein source like Black Soldier Fly (BSF) are being explored to lower fish feed costs. Strengthened enforcement measures and supportive policies and legislation are under development to ensure a comprehensive legal framework and long-term sustainability and productivity of the sector.

PROGRESS AND ACHIEVEMENTS OF THE ZAMBIAN GENETIC IMPROVEMENT PROGRAM FOR *Oreochromis andersonii*

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Zambia is the leading aquaculture producer in Southern Africa with the current fish production from the sector at 89,342 MT [1]. There are several indigenous and exotic tilapia species cultured in Zambia's aquaculture industry. *Oreochromis andersonii,* commonly known as the three-spot tilapia, is among the commonly farmed indigenous species. The production of exotic species of tilapia is limited to designated production regions and prohibited in areas where indigenous species like *O. andersonii* naturally occur, limiting productivity and profitability of aquaculture farmers in these areas who depend on the species genetically unimproved seed. Growth rate, feed conversion efficiency and survival are the main determinants of productivity in fish farming and improving these traits is crucial. The objective of this paper is to present the genetic improvements achieved through pedigree-based selection, in the first two generations (G1 & G2) of the Genetic Improvement Program (GIP) funded by the Government of Zambia and the African Development Bank.

The pedigree-based program targeting growth as the key trait, commenced in 2019 with disease free founder populations from the Kafue, Luangwa and Zambezi River systems. The first generation was produced in 2022 and we found a significant heritability for growth rate. We achieved 12.6% genetic gain for growth in the first generation and 11.5% in the second generation. Our results are similar to the 12% (range of 3.6% to 20.5%) average genetic gain per generation obtained for growth for tilapia based on 17 estimates of 4.6 average number of generations of selection[2]. Currently, the third generation (G3) of *O. andersonii* is under grow-out stage and the GIP has disseminated its first batch of the generation two (G2) improved seed to the government hatchery which will in turn multiply and disseminate to farmers across major aquaculture zones in Zambia.

The significant heritability and genetic gains for growth achieved over the last two generations of *O. andersonii* indicates growth can be improved by selective breeding in the species. Improved growth in the species means a relatively shorter production cycle, reduced costs and increased profitability for *O. andersonii* farmers. Integration of new traits including survival and feed conversion efficiency will further benefit the program.

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FISH TRADE IN COMESA AND OPPORTUNITIES FOR IMPROVEMENT

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The Common Market for Eastern and Southern Africa (COMESA) region boasts some of Africa's most important fisheries resources. These include marine resources in the Western Indian Ocean, Southeast Atlantic, Mediterranean and Red Sea, as well as the vast freshwater systems of the Nile, Congo, Zambezi Basins, and the Great Lakes within them. Cognizant of this resource abundance, one can say, fisheries are one of the most significant resources that COMESA countries have for food and nutrition security, livelihoods, public revenue and socio-economic growth.

Trade in fish and fishery products plays an important role in the economies of COMESA Member States through the creation of employment, food and nutrition supply, and income generation at the different value chain nodes. Intra COMESA fish trade has grown from 41,000 tons in 2019 to 62,000 tons in 2022. Whereas imports of fish and fish products to the COMESA region have reduced from 3.8 million tons in 2029 to 3.4 million tons in 2022. In general, the importation of fish and fish products to the COMESA region is by far larger compared to exports from the region. This mainly attributes to the fact that the large proportion of fish trade within the region remains informal due to the artisanal nature of production scattered in the remote landing sites compounded by the complexity of the players in the sector. On the other hand, safety standards of fish and fish products have witnessed improvement, with medium-to-large manufacturing facilities for processing and packaging playing a significant role, especially in countries experiencing a surge in fish and fish product volumes.

Deliberate efforts and initiatives to facilitate fish and fish products trade among the COMESA Member states including Simplified Trade Regime and the one boarder post among others have contributed to an increase in fish trade and have improved the incomes and livelihoods of the small-scale fish traders and other value chain actors through domestic, intra and inter-regional fish trade activities.

AQUATIC BLUE FOODS COALITION - A VEHICLE FOR BRINGING SUSTAINABLE AQUATIC/BLUE FOODS INTO THE SPOTLIGHT AND INTO FOOD SYSTEMS DECISION-MAKING PROCESSES

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Blue, or aquatic, foods are fish, shellfish, aquatic plants, and algae caught or cultivated from freshwater and marine environments. These foods hold immense promise in supporting diets that are healthy, sustainable, inclusive, and climate-resilient. That's a critical step to enable our food systems to achieve progress on the Sustainable Development Goals.

The Aquatic Blue Foods Coalition (ABFC) was born from the recognition that sustainable and equitable food systems are vital for achieving the Sustainable Development Goals. Formed after the UN Food Systems Summit 2021 and officially launched at the UN Ocean Conference 2022, the Coalition aims to ensure that the diversity and the potential of blue foods are fully integrated into equitable solutions for global food and nutrition security, a resilient climate, and a thriving biodiversity.

Thus the objectives of the ABFC are to: (1) Raise the profile of blue foods through engagements with high-level decision-makers at national, regional, and international levels to advocate for the recognition and integration of blue foods' potential in transformations towards food systems that deliver for both people and the planet (2) Mobilize support by connecting and working with multiple stakeholders to mobilize investment, technical capacity and partnerships for countries, or groups of countries, looking to integrate aquatic foods into their food systems policy; (3) Drive knowledge exchange and place-based action, fostering knowledge exchange between members and provide them with support to catalyze action in key regions and/or countries by helping them understand their blue food needs and possibilities, and matching them with funding and/or technical assistance.

The Aquatic Blue Foods Coalition (ABFC) has partnered with the AUDA-NEPAD, WAS and other partners in striving to achieve these objectives in Africa - and are embarking on knowledge exchange platforms with ultimate goal of raising the profile of blue foods.

INITIATIVES IN WIND ENERGY FOR WELL WATER EXTRACTION IN KENYAN RIPARIAN LANDS

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Wind energy is a green and renewable source of energy that can compete effectively in increasing world of electricity market. The initial capital investment in wind energy goes to the machine and other supporting infrastructure. Wind energy can be used to generate underground water for use domestically and in aquaculture in Riparian communities and general households to beef up food security in our society. Water flow in wetlands ecosystems can be irregular and of limited supply in many Riparian livelihoods, furthermore water from streams and rivers is becoming scarce. Therefore, using wind energy to tap underground water can provide livelihood to Riparian communities and general households. Underground well water extraction can provide continuous water supply and effectively close the gap of clean water, shortage for Riparian farming and general use in homes. A mathematical model of a wind turbine is essential in understanding the behaviour of wind over its region of operation. Modelling also enables control of wind turbines performance in Riparian and general household areas. Through this initiative we expect to provide clean continuously flowing water for many households in aquaculture and general use. Furthermore, there are reduced incidences of water borne diseases hence Riparian and household communities can engage in aquaculture and other farming enterprises using wind energy and healthy waters from wells extraction.

INBREEDING DEPRESSION AND ITS EFFECTS ON ARTIFICIAL REPRODUCTION IN THE AFRICAN CATFISH *Clarias gariepinus* (BURCHELL, 1822) IN CAMEROON

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Inbreeding depression results from the mating of closely related individuals which causes reduced biological fitness. Intraspecific hybridization leads to the production of fry and fingerlings that exhibit faster growth rates and better environmental tolerance. There is need to rely on selective breeding and hybridization for the improvement of genetic resources in aquaculture.

This study set out to investigate the reproductive success of *Clarias gariepinus* and the potential effects of inbreeding depression within aquaculture systems in Cameroon. The experiment was carried out in the laboratory and lasted for a period of 10 days involving two strains of *Clarias gariepinus* from river Nyong in Yaounde and river Mapé in Foumban. Fertilization was completely randomized with 4 crossing combinations.

Table 1: Mean±SD weight and length of *Clarias gariepinus* strains of Nyong and Mapé

Parameters	Mapé Male	Mapé female	Nyong Male	Nyong Female	ANOVA T-test
Mean weight	$2.52{\pm}0.85^{a}$	$2.33{\pm}0.18^{a}$	$2.88{\pm}0.56^{a}$	$2.91{\pm}0.66^{a}$	$p>0.05$
Mean length	$70.25{\pm}8.84^{ab}$	$65.05{\pm}1.06^{b}$	$74.8{\pm}3.11^{a}$	$72{\pm}4.81^{a}$	$P<0.05$

Values on the same row with same superscript letters are not significantly different ($p>0.05$).

Table 2: Fertilization, hathability and Survival rate of purebred and crossbred larvae

Parameters	NM2NF2	NM2MaF	MaMNF2	MaMMaF	T-test
Fertilization rate	$21.28{\pm}50.81^{c}$	$26.27{\pm}305.42^{c}$	$54.54{\pm}411.65^{a}$	$46.78{\pm}168.01^{b}$	$p<0.05$
Hatchability	$0.56{\pm}0.00^{b}$	$0.36{\pm}3.21^{b}$	$0.44d{\pm}5.13^{b}$	$75.10{\pm}134.50^{a}$	$p<0.05$
Survival	$15{\pm}2.12^{d}$	$20{\pm}3.54^{c}$	$50{\pm}88.39^{a}$	$78{\pm}777.82^{b}$	$p<0.05$

Values on the same row with same superscript letters are not significantly different ($p>0.05$).

PRODUCTION OF TILAPIA AND PLANTS IN A HOME GROWN AQUAPONIC SYSTEM

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Aquaponics system includes an integrated agricultural complex of recirculating aquaculture and soilless plant culture under hydroponic conditions. Small aquaponics units containing 1m^3 fish tank and 3m^2 plant cultivation area are considered as home grown. Results of the current experiment about production in a small aquaponics unit showed it is estimated that more than 50 kg of tilapia fish and about 15-77 kg of healthy vegetables can be produced, yearly.

Production in aquaponics system contributes to water and soil conservation and food security and is in line with environmental considerations. Small aquaponics units are considered as home grown units and the main purpose of their implementation is to produce food for subsistence and household consumption. In the present experiment, small aquaponics with 1m^3 fish tank and 3m^2 plant cultivation space were implemented. Production of tilapia fish and plants was carried out in two periods. Red hybrid tilapia, *Oreochromis* sp. monosex males were stocked at densities of 58 and 55 fish/m^3 and average weights of 74.6 and 51.6 grams, respectively. The cultivated plants were peppermint, *Mentha piperita*, celery, *Apium graveolens* and green basil *Ocium basilium*. In the two production periods, the fish harvest was 26.6 and 25 kg, peppermint harvest was 10.7 and 1.8, celery 9 and 16.7, and green basil 2.6 kg/m^2. In total, by implementing a home grown aquaponics unit with proper production management and maintaining favorable environmental conditions, in a one-year period, it is estimated that more than 50 kg of tilapia fish and about 15-77 kg of healthy vegetables can be produced, depending on the type of plant cultivated. Promoting home aquaponics production units leads to the production of healthy fish and plants, an increase in per capita consumption of aquatic animals, access to fresh products throughout the year, and the creation of rural and home jobs.

FISH HEALTH MANAGEMENT STRATEGIES FOR CLIMATE SMART AQUACULTURE IN L. VICTORIA

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Lake Victoria's thriving blue economy has provided a livelihood for half a million individuals in Kenya, Tanzania, and Uganda in the past. However, climate change, pollution, invasive species, declining fish stocks, and water inlet interference have threatened the lake's potential, resulting to cage farming as a means to rear fish through climatic disruptions. Furthermore, climate change alters environmental conditions and disease dynamics, thus posing significant impacts to aquaculture. Higher water temperatures coupled with extreme weather events can worsen pathogen risks and stress farmed aquatic animals, making them more susceptible to disease. Coupled with rising intensification of cage culture, there is need for enhanced adaptation strategies to cope with changing environmental conditions for long term sustainability of livelihoods of fishermen and fish farmers. To ensure an appreciable level of disease prevention and control, effective biosecurity strategies, increased capacity building, comprehensive policy and regulatory provisions are a necessity for sustainable livelihoods for fisher-folk in Lake Victoria region.

APPARENT PROTEIN DIGESTIBILITY AND GROWTH PERFORMANCE OF NILE TILAPIA (*Oreochromis niloticus* L.) FED ON SUNFLOWER AND COTTON SEED MEAL AS SUBSTITUTES FOR FRESHWATER SHRIMP MEAL (*Caridina nilotica*)

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Fish feed is critical in aquaculture production, accounting for over 60% of operational costs, with protein being the most expensive component. Traditionally, fish meal (FM) has been the primary protein source. However, due to declining capture fisheries and high demand, FM has become scarce and costly, necessitating the search for alternative, low-cost, and nutritionally balanced protein sources. A 180-day feeding experiment was conducted to evaluate the effects of replacing FM with a combination of cottonseed and sunflower meal (SFM) in Nile tilapia diets on growth performance, protein digestibility, and economic returns. Freshwater shrimp meal was replaced at 25%, 50%, 75%, and 100% (diets D1, D2, D3, and D4) and compared to the control diet (D0) containing only FM. Monosex Nile tilapia fingerlings (25 ± 0.01 g) were allocated to 15 cages within an 800 m^2 earthen pond. Fish on diets D0 and D1 showed superior growth performance metrics, including final mean body weight, weight gain, daily weight gain, specific growth rate, feed conversion ratio, and survival rate ($p > 0.05$), compared to diets D2, D3, and D4. Growth performance declined significantly with increasing levels of the plant protein mixture ($p < 0.05$). Diet D0 had the highest apparent protein digestibility, while D4 had the lowest. Cost-benefit analysis revealed that diet D0 had the highest production cost, followed by diets D1, D2, D3, and D4, with no significant cost difference between D0 and D1 ($p > 0.05$). Thus, the plant protein mixture can effectively replace FM at a 25% inclusion level in Nile tilapia diets.

SOCIO-ECONOMIC DRIVERS OF USE OF *Mormyrus kannume* AS A BAIT IN NILE PERCH FISHERY: TOWARDS SUSTAINABLE USE AND MANAGEMENT

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Socio-economic factors play a pivotal role in shaping conservation practices by influencing the decisions and preferences of resource users. This study investigates the key socio-economic drivers behind the use of *Mormyrus kannume* as bait in the Nile perch (*Lates niloticus*) fishery.

Data was collected in March 2023 by administering a semi-structured questionnaire to respondents. A total of 166 respondents were interviewed at seven (7) selected landing sites along the Upper Victoria Nile and Lake Victoria. Results showed that socio-economic factors (bait type, bait cost, fishing experience, bait size and selling price of Nile perch) strongly influenced bait choice. There was a statistically significant relationship between bait cost and bait type selected (*M. kannume*, catfish, mudfish, and *Synodontis*) ($P<0.05$). Fishermen with 11–20 years of experience were more likely to use *M. kannume*, indicating that experience significantly influenced bait preference ($P<0.05$).

The size of the bait was significantly related to the size of Nile perch caught, which in turn influenced the market price, stressing the economic value of bait selection ($P<0.05$). *Mormyrus kannume* was the most preferred bait due to its effectiveness in luring Nile perch but was also the most expensive, ranging from US$0.27–1.09 per piece compared to US$0.03–0.27 for alternatives. Its high demand has resulted in increased scarcity, leading to subsequent targeting of populations at or below L_{50} thus limiting recruitment of the populations in the wild. This has resulted into overexploitation of the fish.

The study emphasizes the need to integrate socio-economic considerations into fisheries management strategies in promoting sustainable use of *M. kannume*. Development of national bait-use policies should include restriction of use of basket traps that catch young juveniles, ensure inclusion of co-management aspects with fisher communities and developing of captive breeding programs to ease pressure on wild populations.

CONTRIBUTION TO THE ASSESSMENT OF CERTAIN MICROPOLLUTANTS IN THE WATERS OF INTEGRATED AQUACULTURE AND AGRICULTURE FARMS IN SENEGAL

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Tilapia and clarias are the main species farmed in Senegal. However, access to fish feed represents a major challenge, mainly due to the lack of local production plants and the high costs associated with importing quality feed. In addition, the use of plant protection products in agriculture poses risks to human health, the environment and biodiversity. Unfortunately, many pesticide users are often unaware of these risks. The aim of our study was therefore to assess the presence and quantity of pesticides and heavy metals in water (feed and livestock) and fish in the northern and southern zones of Senegal. First, a survey phase enabled us to take stock of the situation of fish farms integrated into agriculture. This phase was carried out using questionnaires previously drawn up with Sphinx® software. This was followed by water sampling campaigns to analyze the presence of plant protection products (PPP) and trace metal elements (TME). A total of 49 waters samples (feed and livestock) were collected between 2022 and 2023. Samples were analyzed by high-performance liquid chromatography-tandem mass spectrometry (HPLC-ESI-MS/MS) using HPLC-LC20AD (Shimadzu, Marne-la-Vallée, France) coupled with a QTRAP® 5500 system (Sciex, Villebon-sur-Yvette, France). Concentrations of Cd, Cu, Pb and Zn were measured in the dissolved phase by inductively coupled plasma mass spectrometry (ICP-MS). The presence of certain PPPs such as Metolachlor, DEET and atrazine was noted, but only in small quantities. This is not a serious problem, although it does call for regular monitoring of water quality and practices. These results could contribute to the development of effective strategies to support fish farmers and farmers, and thus strengthen the competitiveness of the aquaculture and agricultural sectors in Senegal with regular monitoring and surveillance.

FARMED CATFISH *(Clarias gariepinus)* AS BAIT IN THE NILE PERCH LONGLINE FISHERY: EVIDENCE FROM UGANDA

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In East Africa, farmed North African catfish (*Clarias gariepinus*) is primarily produced for human consumption, requiring grow-out periods of at least six months or more. However, catfish grown to smaller sizes—achievable in just under three months—can serve as bait in the Nile perch (*Lates niloticus*) longline fishery. This alternative use remains largely untapped, despite its potential to create a viable market for small-scale farmers who lack the resources to grow fish to human consumption size. A 2023 survey conducted by NaFIRRI and the University of Heidelberg in the Ugandan part of Lake Victoria found that over 71% of longline fishers were sure that they were using wild-based bait, mainly *Haplochromines spp* and *Mormyrus kannume*. Wild bait, while low-cost and/or sometimes got at no monetary cost (fished before embarking on the actual fishing trip), is unsustainable and usually associated with illegal gear use, immature fish capture, wetland degradation, and depletion of forage species important for the Nile perch food web. In contrast, farmed catfish is a potentially more sustainable and regulated alternative.

In September 2024, a randomized controlled trial involving 83 longline boats across seven landing sites in Uganda assessed the viability of farmed catfish as bait. Treatment boats received 400 units of African farmed catfish, while control boats continued the usual practices with wild bait. Catch outcomes were compared between the two groups.

FROM VERTICAL INTEGRATION TO STRATEGIC CONGLOMERATION: SCALINE AFRICAN AQUACULTURE THROUGH SMARTER VALUE CHAINS

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Many African aquaculture industries have been shaped by vertically integrated companies that build markets, infrastructure, and employment. As the sector matures, a new model is needed: conglomerates that span related sectors—hatcheries, feed mills, logistics—creating efficiency and value across the chain.

Such conglomerates can unlock cost savings and innovation that smaller, standalone companies often cannot—particularly in feed, which remains the largest production cost. Because these businesses are specialised but interlinked, they're motivated to reduce inefficiencies and experiment with novel approaches: supporting a long-term vision for the sector as a whole.

One promising example for SME customers is hybrid feeding: starting production with low-cost nutrition such as fertilised green water, then finishing with high-protein commercial feed. This model offers savings while supporting good growth rates.

By integrating service providers, small farms, feed innovators, and traders into these ecosystems, we can build local value chains that proactively enable SME growth—not in isolation, but as part of an aligned commercial system.

THE EFFECT OF DIETARY FISHMEAL REPLACEMENT WITH BLACK SOLDIER FLY LARVAE MEAL ON THE NUTRITIONAL COMPOSITION AND HEAVY METAL CONTENT OF THE FILLET OF FARMED JUVENILE DUSKY KOB *Argyrosomus japonicus*

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The demand for sustainable aquaculture feeds has led to the exploration of alternative protein sources, including insect meals. This study investigated the effect of replacing dietary fishmeal (FM) with black soldier fly larvae meal (BSFLM) on the nutritional composition and heavy metal content of fillet tissues from farmed dusky kob (*Argyrosomus japonicus*) juveniles. Four isonitrogenous, isolipidic, and isocaloric experimental diets were formulated by replacing FM with BSFLM at 0, 33, 66, and 100%. After a 96-day feeding period (starting from 131 ± 0.33 mm/fish standard length), three replicates of an approximately 200 g pooled sample of skinless fillets (from five specimens) were collected from each dietary group for analyses of proximate composition, amino acids (AAs), fatty acids (FAs), trace elements (iron, zinc, copper, chromium, cobalt, and nickel), and heavy metals (lead, mercury, cadmium, and total arsenic). Proximate composition (moisture, crude fat, crude protein, and ash) was determined by oven-drying, Soxhlet extraction, the Dumas method, and furnace incineration, respectively. Amino acids were measured using high-performance liquid chromatography, and FA were analysed by gas chromatography-mass spectrometry following transesterification. Trace elements and heavy metals were quantified using inductively coupled plasma-mass spectrometry.

No significant differences ($p>0.05$) were found in the fillet's proximate composition among fish fed the four diets. While the content of most analysed amino acids (histidine, serine, arginine, glycine, aspartic acid, glutamic acid, threonine, alanine, proline, tyrosine, phenylalanine, leucine, lysine, and methionine sulfone) remained unaffected, the essential AA valine was significantly lower in fish fed the 100% BSFLM diet compared to the control and 33% BSFLM diets, and isoleucine decreased at 66% and 100% BSFLM. No significant differences ($p>0.05$) were observed in the content of FAs such as docosahexaenoic acid and the essential FAs linoleic acid and linolenic acid—except for the non-essential monounsaturated fatty acid palmitoleic acid, which was reduced as BSFLM inclusion increased. Mercury and arsenic concentrations also decreased with higher BSFLM inclusion, whereas trace elements and other heavy metals showed no significant differences.

Overall, these findings suggest that BSFLM-based feeds are a viable alternative to FM-based diets from a nutritional standpoint, providing stable key nutrients in the fillet and reducing mercury and arsenic levels, despite modest decreases in certain essential amino acids at higher inclusion levels.

EVALUATING THE DIVERSITY OF GUT BACTERIAL MICROBIOME OF *Oreochromis niloticus* AT VARIOUS GROWTH STAGES IN CAGE CULTURE SYSTEMS ON LAKE KARIBA, SIAVONGA

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Bacteria organisms populating the gastrointestinal tract (GIT) play a very important role in supporting host physiology and environmental adaptation. This study investigated the bacterial diversity and composition across GIT regions of *Oreochromis niloticus* grouped by size (4–20 g, 21–50 g, 51–150 g, >200 g). Total bacterial counts, Enterobacteriaceae, and Vibrionaceae were quantified. Results showed significant disparities by size and GIT region, with posterior intestines harboring the highest bacterial loads. Enterobacteriaceae peaked in larger fish (>200 g), while Vibrionaceae surged in intermediate-sized fish (21–50 g), suggesting size-dependent colonization.

Dominant genera (*Bacillus*, *Lactococcus*, *Staphylococcus*, *Lactobacillus*, *Clostridium*) exhibited distinct distribution patterns, with diversity increasing in larger fish, particularly in posterior intestines. Smaller fish showed reduced microbial diversity. These findings highlight the dynamic relationship between fish size, GIT region, and microbial communities, emphasizing their role in aquaculture sustainability and bacterial disease management.

BIOCONVERSION EFFICIENCY OF BLACK SOLDIER FLY LARVAE ON COMBINED AQUACULTURE SLUDGE AND BREWERS' GRAINS SUBSTRATES

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Introduction:
This study investigates the bioconversion efficiency and nutritional outcomes of Black Soldier Fly (BSF) larvae (*Hermetia illucens*) reared on substrates combining aquaculture sludge (AS) and brewers' spent grains (BG). The objective was to identify the optimal AS inclusion level that maximizes larval growth and nutrient composition, offering a sustainable approach to waste valorization. Frozen aquaculture sludge was thawed at room temperature and thoroughly hand-mixed. Five experimental substrates were formulated:

- Control (C): 100% BG
- T1: 25% AS + 75% BG
- T2: 50% AS + 50% BG
- T3: 75% AS + 25% BG
- T4: 100% AS

Substrate moisture was adjusted to 70% (except for the control) by adding distilled water, aligning with findings by Bekker et al. that optimal BSF larval growth occurs at moisture levels between 65–75%. Larvae were reared under controlled conditions (28 ± 1°C, 70% RH) for 14 days. Growth performance metrics included larval weight gain, survival rate, and development time. Post-harvest, larvae were analyzed for proximate composition: crude protein, lipid, ash, and moisture content.

Results:
Results indicated that T2 (50% AS + 50% BG) achieved the highest larval weight gain (0.45 g/larva), survival rate (95%), and optimal development time (12 days). Proximate analysis revealed that T2 larvae had the highest crude protein (42.5%) and lipid content (28.3%), with moderate ash (8.2%) and moisture levels (10.5%). These findings suggest that a balanced 50:50 ratio of AS and BG provides an optimal nutrient profile and growth environment for BSF larvae.This study demonstrates the potential of integrating aquaculture sludge with brewers' spent grains to enhance BSF larval production, contributing to sustainable waste management and alternative protein sources.

Table 1: Growth Performance of BSF Larvae on Different Substrates

Treatment	Larval Weight Gain (g/larva)	Survival Rate (%)	Development Time (days)
C	0.30	85	14
T1	0.38	90	13
T2	0.45	95	12
T3	0.33	88	13
T4	0.25	80	15

Table 2: Proximate Composition of BSF Larvae (% Dry Matter)

Treatment	Crude Protein (%)	Lipid (%)	Ash (%)	Moisture (%)
C	35.0	20.5	10.0	12.0
T1	38.7	24.0	9.0	11.5
T2	42.5	28.3	8.2	10.5
T3	36.8	22.7	9.5	11.8
T4	32.0	18.0	11.0	13.0

The superior performance of T2 underscores the efficacy of a 50:50 AS and BG substrate in promoting BSF larval growth and nutritional quality, offering a viable strategy for sustainable waste utilization and protein production.

CLIMATE, COMMUNITIES, AND FISHERIES: UNDERSTANDING DRIVERS AND IMPACTS IN KENYA'S AQUATIC ECOSYSTEMS

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This study investigates the temporal associations between environmental and socioeconomic variables and their impact on capture fisheries production, aiming to guide sustainable fisheries management and policy development. To achieve this, various statistical techniques were employed to uncover these relationships. The Mann-Kendall test indicated increasing trends in mean annual temperature, greenhouse gas emissions (GHG), domestic credit to the private sector, agricultural land use, and population density, with no trend in freshwater withdrawals. The Augmented Dickey-Fuller (ADF) test revealed non-stationarity in all variables except temperature. Cross-correlation analysis with pre-whitening showed negative associations between mean annual temperature and population density with fisheries production, with delays of one and 13 years, respectively, though these were not statistically significant. GHG emissions showed a negative association with fisheries production at a six-year lag ($r = -0.40$), while domestic credit was negatively correlated ($r = -0.255$) at the same lag. Agricultural land use exhibited a significant positive correlation ($r = 0.44$) at a five-year lead. These findings highlight that fisheries sustainability is increasingly threatened by climate change, population growth, and land use changes. The study underscores the need for integrated fisheries management approaches that account for interdependencies between terrestrial and aquatic ecosystems while aligning with climate adaptation.

A SYSTEMS APPROACH TO SUSTAINABLE AQUACULTURE: INTEGRATING ECONOMIC RISK, SUPPLY ELASTICITY, AND STOCHASTIC DYNAMICS

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Sustainable aquaculture production is influenced by ecological, economic, and environmental uncertainties, yet traditional models often rely on extensive external datasets, making them less applicable in data-scarce regions. This study introduces a Geometric Stochastic Pella-Tomlinson Model that integrates supply elasticity, risk-adjusted economic factors, and environmental variability to optimize aquaculture production in Kenya. By incorporating state-dependent diffusion, the model ensures that stochastic fluctuations scale with production levels, ensuring realistic dynamics, while the Hamilton-Jacobi-Bellman equation is used to derive optimal harvesting strategies under uncertainty. A novel formulation of supply elasticity and its relationship with economic risk using stochastic calculus, along with a risk-sensitive quadratic framework for price elasticity captures market fluctuations. Monte Carlo simulations validate the robustness of the model across varying production conditions, demostrating that higher economic risk correlates with greater supply elasticity, reflecting producers' responsiveness to price fluctuations in uncertain environments. The model effectively captures declines in aquaculture production due to harvesting pressure, environmental degradation, and market volatility, while price elasticity initially exhibits high sensitivity before stabilizing as risk perception and market responses adapt over time. By aligning with One Health Framework, this approach integrates economic, environmental and ecological factors, providing a data-driven decision-support tool for fisheries managers, to enable risk-aware policy interventions, adaptive production planning, and improved resource allocation. Additionally, by optimizing parameters solely from production data, this framework eliminates reliance on hard-to-access economic datasets while capturing essential economic and ecological interactions. Future research should incorporate real-time economic shock modelling and climate variability to refine the interplay between supply elasticity, market dynamics, and environmental sustainability.

BLACK SOLDIER FLY LARVAE: A SUSTAINABLE SOLUTION FOR ORGANIC WASTE MANAGEMENT AND FEED INNOVATION IN ETHIOPIA

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Ethiopia faces growing challenges in organic waste management and the need for alternative protein sources to support aquaculture and livestock production. Black Soldier Fly (BSF) larvae (*Hermetia illucens*) offer a transformative solution, efficiently converting organic waste into nutrient-rich biomass for animal feed. This study evaluates the potential of locally available organic wastes: avocado waste, brewery spent grain (BSG), green offal, poultry manure, and potato waste as substrates for BSF larvae rearing. The study was conducted at the Addis Ababa University Department of Zoological Sciences' Insect Rearing Facility. The experiment assessed larval growth, waste reduction efficiency, and nutritional composition across six treatment groups with four replications.

Treatment groups differed significantly ($P < 0.05$). Results indicate that BSG exhibited the highest biomass yield, superior waste conversion efficiency (SRR: 75.71%, BCE: 20.34%), and a high protein content (CP:37.89%), closely rivaling control feed (chicken starter feed; SRR: 74.03%, BCE: 17.15% and CP: 38.48). Notably, despite its low nutrient value, green offal (GO) feeding resulted in a substantial 3.65-fold increase in larval crude protein to 30.38%, and the larvae fed potato waste, the substrate with the lowest initial fat content, exhibited the highest larval fat content, showing a remarkable 46-fold increase, highlighting BSFL's capacity to valorize low-value organic waste. While all tested organic wastes supported larval rearing, exploring value-adding strategies could further enhance their performance.

These findings underscore the significant bioconversion capacity of BSFL to concentrate protein and fat from diverse feedstocks. Consequently, this study highlights the viability of BSF larvae as a scalable, eco-friendly waste management tool and a sustainable feed alternative for Ethiopia's agricultural and aquaculture sectors, contributing to circular economy models and innovative waste-to-resource technologies that support food security and environmental sustainability.

Larvae	*%CP*	*%EE*	*%CF*	*%Ash*	*NSC %*
L1	34.77	24.63	5.5	11.39	23.71
L2	37.89	30.22	3	5.77	23.12
L3	30.38	25.05	3.7	15.4	25.47
L4	37.21	23.2	4.5	13.48	21.61
L5	35.8	23.4	3	12.92	24.88
L6	38.48	30.2	2	12.66	16.66

Table1. Nutrient composition of BSFL

Parameter	**AW**	**BSG**	**GO**	**PM**	**PW**	**Control**	**P-value**
SRR	68.61	75.71	66.77	67.01	74.72	74.03	< 0.01
SRI	4.36	4.63	4.11	4.15	4.68	4.80	< 0.01
BCE	13.20	20.34	14.17	18.73	12.35	17.15	< 0.01

Table 2. Substrate reduction potential of BSFL

GENDER EMPLOYMENT GOVERNANCE AMONG PRIVATE FIRMS IN AFRICA

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African countries are promoting aquaculture as one of the prime drivers of the rural economy and the employment of women and youth. The industry is criticized for inadequately representing the needs of women and workplace gender equality. Most African countries, however, are willing to advance the aquaculture industry goals through employment practices promoting gender equality. Hence, this paper investigates whether aquaculture employment governance promotes legislations that enhance gender employment equality and opportunity.

A survey of 84 private aquaculture enterprises was conducted in ten African countries (Egypt, Ghana, Kenya, Malawi, Nigeria, Rwanda, Senegal, South Africa, Uganda, and Zambia) from November 2021 through September 2022. Data on production trends and spatial distribution of industries were reviewed to select farms or operations representing each country's industry. The structured interview guide focused on recruitment and employment, employee characteristics, demographic distribution, qualifications, working conditions, and property rights. The data collected were synthesized and analyzed to establish differences in gender participation along the supply chain.

The results show that the individuals employed in the aquaculture labour force are young and dominated by men 15 to 35 years old. The gender gap in workers employed in aquaculture is broader than that of the average global gap between the aquaculture workforce and those used in the country's workforce. The most significant gap is Rwanda (106.61), and the lowest is Egypt (22.85). School attendance and graduation rates illustrate a wide educational gap between young men and women, creating a gender imbalance. The level of education and biases in employment seem to reduce women's participation in the aquaculture labor workforce. The proportion of individuals surveyed had some higher education or completed high school, but women had a lower educational attainment than men. Women are under-represented at the higher nodes of the supply chain, and the divulged reason is a lack of education. In administrative support, the ratio of men to women in 2022 was 52.8:47.2, close to a 50:50 split. Women dominated administrative support in Ghana, Nigeria, South Africa, Uganda, and Zambia. Most women are employed in post-harvest activities and as office administrators. Men were far more dominant as technicians with a ratio of 93.5:6.5. It would be expected that women would dominate the labor classification since they are heavily recruited for processing and trade, but this was not the case since men also dominated the labor class at 83.6:16.4. All aquaculture workers receive at least the minimum pay with additional bonuses, comparable to men doing the same job. Accommodation limits women's participation in cage culture because of the distance away from home. In most instances, women choose part-time or occasional employment because only three countries, Ghana, South Africa, and Zambia, grant maternity leave to employees. Ghana also provides paternity leave. South Africa is the only country that grants a mother a nursing break. The future of women's employment depends on the growth in women registered at institutions of higher learning in the field or related aquaculture fields since all countries encourage women's participation in the workforce despite resource accessibility.

AQUACULTURE EMPLOYMENT GOVERNANCE IN AFRICA

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Aquaculture in Africa is expanding faster than the average global annual growth rate of 15.6 percent. Most of this rapid expansion is due to large-scale and medium-scale investments in cage culture in large bodies of water. African governments aim to improve public and private governance to enhance the performance of aquaculture administration, attract investors through combinations of public and private regulations, codes, and employment standards, and improve public perception of the industry. This study seeks to evaluate existing employment governance in African aquaculture.

This study was undertaken from November 2021 through September 2022. It involved an intensive literature review of national government documents, scientific papers, and relevant FAO and ILO documents. Ten reports on the governance of aquaculture employment from Egypt, Ghana, Kenya, Malawi, Nigeria, Rwanda, Senegal, South Africa, Uganda, and Zambia are summarized to evaluate the existing nature of employment governance.

Multiple departments, ministries, and agencies direct aquaculture governance, but each ministry operates independently; thus, no consolidated groups assist the ministry responsible for integrating planning and decision-making. All countries have some bureaucratic procedures for employment governance, either in one ministry or spread throughout various ministries. The present legislation, which is frequently distributed at the levels of multiple ministries and departments, is usually overly burdensome and cumbersome. Processes to access public services often involve excessive red tape. The types of governance vary by country, with hierarchical governance predominating at the public level. Countries exhibit multiple combinations: Egypt is hierarchical and command and control; Senegal is hierarchical and decentralized; and Zambia is participatory and collective. The private sector enterprises in the countries exhibit participatory forms of governance. Employers comply with all rules and regulations, recruiting staff with high school diplomas, some high school education, or advanced education. Although most of the companies follow the ILO and the government's employment laws, most of their employees are permanent but without signed contracts. All companies reported no discrimination in wages or salaries offered to employees, as compensation depended on the position and job description (equal job, equal pay principle). The salaries and wages in the sector are comparable to those in the livestock and crop subsectors. No instance of social dumping was observed. Employed expatriates are either part of the foreign investor's organization or employed as chief executive officers who are part of the managing team.

Companies offered several benefits and incentives to employees, including food basket gifts, overtime pay, free accommodation, free meals, and invitations to join the organization by purchasing stock options. However, the survey results reported that not all the companies surveyed are willing to cover employee health costs. To stimulate and protect private-sector investment and ensure sustainability of the sector, countries in Africa need to promote policies, solicit high-level support, and enforce regulations governing employment to enhance worker productivity. Additionally, concerted efforts should be made to develop universal guidelines for employment governance in aquaculture.

THE GUIDELINES FOR SUSTAINABLE AQUACULTURE TENTATIVE SESSIONS: COUNTRY BRIEFS AND CEOS FORUM

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Globally, aquaculture plays a crucial role in meeting the rising global demand for aquatic foods of an expanding world population expected to reach 9.7 billion by 2050. Aquaculture was first introduced to Africa over 50 years ago. Africa's aquaculture sector is the fastest growing in the world at 11% annually. However, its contribution to global aquaculture production is still relatively low (less than 3% in 2022). In 2022, sub-Saharan Africa's (SSA) aquaculture sector contributed less than 1% to global aquaculture production. Although Africa has experienced improvements in public infrastructure such as transportation and roads, access to communication by phones and internet, and an increased supply of education and health care in the production areas, many countries still face challenges. Challenges such inadequate public and private investment on aquaculture infrastructure for research, training, and extension, limited access to quality inputs (seeds and feeds, insufficient technical and managerial capacity; weak value chain development; limited access to loans for small- and medium-scale farmers, poor market access and linkages, ineffective governance, and climate change impacts, need to be addressed.

The aquaculture sector needs an holistic approach departing from broader rural and peri-urban development. The new FAO Guidelines for Sustainable Aquaculture (GSA), developed by FAO and its Members, serve as a tool to guide policy processes, decision-making and action at all levels - local, national, regional and global. GSA highlighted an adaptable framework, designed to address the challenges posed by the rapid growth of the aquaculture sector, supporting its sustainable expansion and intensification in alignment with the FAO Blue Transformation roadmap . They support the implementation of the FAO Code of Conduct for Responsible Fisheries and the 2021 COFI Declaration for Sustainable Fisheries and Aquaculture and enable aquaculture to contribute effectively to the 2030 Agenda.

The GSA enable a broader framework in guiding the sustainable aquaculture in terms of governance and policy, planning, natural resources management, on-farm management, social responsibilities and value chain development. The implementation of the GSA help to mitigate the challenges at the national and regional level, and strengthen the capacity in good aquaculture practices, investment and focus on the sustainability of the sector, and share good practices across nations, regional and global level. As requested by Members, FAO is engaged in mainstreaming the GSA into global, regional and national policies and strategic frameworks in close collaboration with both Members and key stakeholders[1].

This session aims to increase the awareness of the GSA, encourage the engagement of the national authorities to action a plan for GSA implementation, identify key challenges and priorities of aquaculture development in SSA, share experience of good and less good aquaculture practices across the aquaculture value chain, and highlight the sector's potentials in contributing to food, nutrition, livelihood, and social development.

European Union funded project '*Supporting a Blue Transformation: Implementation of the Guidelines for Sustainable Aquaculture (GSA)*'

REPRODUCTIVE BIOLOGY OF NILE TILAPIA *(Oreochromis niloticus)* AND IMPLICATIONS FOR FISHERIES MANAGEMENT IN LAKE HAYQ

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The objectives of the study were to assess the reproductive biology of Oreochromis niloticus and point out implications for fisheries management. Relevant biological data (total length (TL), total weight (TW), sex ratio, maturity stages and fecundity were collected. The collected data were summarized using descriptive (percentage, graphs, tables) and inferential (Chi-Square, Regression) statistics through the application of SPSS. The data were compared with the past reports in the area. A total of 738 samples (422 females and 316 males) were collected during the sampling period. There was a significant deviation in sex ratio (females: males) of (1.3: 1) from the hypothesize 1:1 ratio (X^2 = 15.2, df= 11, P<0.05). The fecundity of O. niloticus ranged from 190 to 616 eggs with a mean of 328 eggs. A strong positive relationship between fecundity and body sizes (fish length and body weight) with r^2 > 0.95 was observed in Lake Hayq. The smallest sexually mature fish specimen caught was 9.3 cm TL and 14 g TW. The size at first sexual maturity (L_{50}) was 11.5 cm for both females and males, which is unexpectedly low. In this study, the main breeding season for O. niloticus was from February to April with peak breeding season in April. Heavy fishing pressure, illegal fishing activities, fishing during the breeding season and breeding ground, and destruction of breeding and feeding grounds are the major problems of Lake Hayq.

SPAWNING MIGRATION CHALLENGES OF *Labeobarbus* SPECIES IN THE RIBB AND GILGEL ABAY RIVERS, LAKE TANA SUB-BASIN, ETHIOPIA: CONSERVATION CONCERNS AND MITIGATION STRATEGIES

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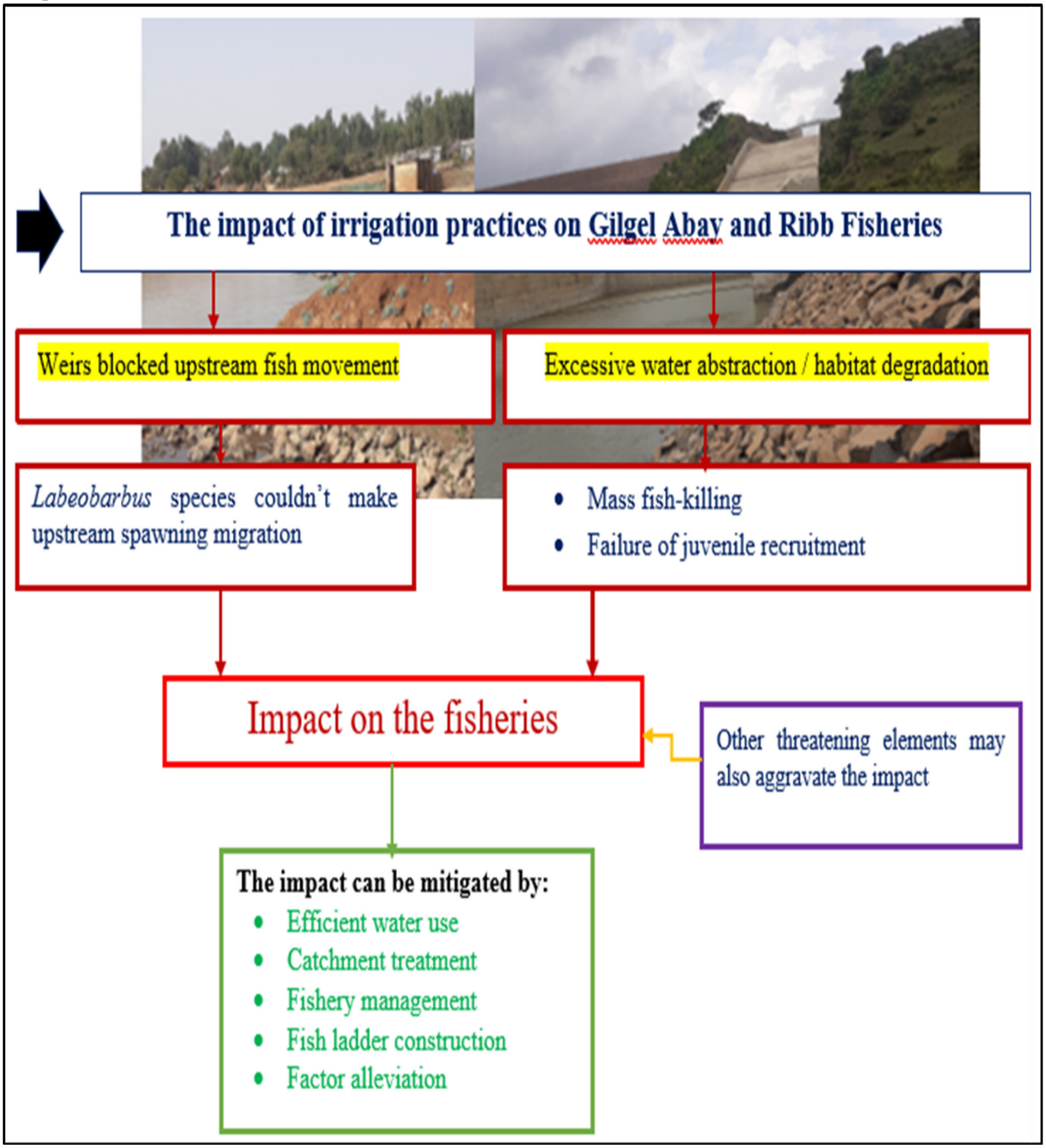
In the Lake Tana Sub-basin, the expansion of irrigation development is increasing without considering fisheries; particularly *Labeobarbus* spp., spawning migrates from Lake Tana to its tributaries during the rainy season. This study investigated the impact of irrigation infrastructure and practices on the spawning migration of these species and proposed potential mitigations. Data were collected from July 2019 to May 2020 through fish sampling above and below the Ribb Dam and Gilgel Abay Weir, interviews with key informants and experts, secondary data collection, and impact significance matrix analysis. The findings revealed that existing irrigation systems disrupt fisheries by blocking spawning migration routes. For instance, fish catches below the Gilgel Abay Weir were significantly higher than those upstream (Shannon Index, $P < 0.001$). Observations also confirmed that even large fish could not jump over the 2-meter-high Gilgel Abay Weir and the Ribb Dam. Local reports indicated that the Ribb River has become seasonal since 2007 due to excessive water abstraction for irrigation, resulting in mass fish killing and a decline in juvenile recruitment to Lake Tana. In one sampling case, over 837 adult fish and numerous juveniles were found dead in the Ribb River and its tributaries. The reduced water volume has also led to non-fishers harvesting fish from pools, while fishers target spawning migratory species at weirs, exacerbating the problem. The study also noted a decline in species diversity compared to earlier records, potentially due to changes in reproductive strategies, sampling inefficiencies, interbreeding, or altered breeding behaviors. Habituat restoration, replacing weirs with environmentally friendly technologies, and constructing fish ladders to mitigate the negative impacts on fisheries.

(Continued on next page)

Graphical Abstract



STATUS OF SEAWEED FARMING IN THE SOUTH COAST OF KENYA AND IMPLICATIONS FOR RESTORATIVE AQUACULTURE

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Seaweed farming has been observed to contribute significantly to the socio-economic development of many coastal households in the south coast of Kenya. To advance the farming, there is a need to understand how the farming is undertaken and if it follows the guidelines of restorative seaweed aquaculture which is considered a promising approach in addressing both environmental degradation and in enhancing local livelihoods. The study assessed the status of seaweed farming in four villages (Tumbe, Bati- Mwazaro, Kibuyuni, Mtimbwani and Mwambao). Questionnaire interviews were used to collect data from the fishers and a total of 153 farmers were interviewed. We established that women dominated seaweed faming activities (72%) and most of them were more than 25 years old. According to 46% of respondents, seaweed farming is the primary livelihood activity, with variations across the five villages. To enhance skills in farming seaweeds, over the past two years, 68% of men and 71% of women farmers had received training on seaweed farming although at different levels in the villages. The trainings were facilitated by multiple actors (government and non-government organizations) and varied topics were covered in the trainings; farming techniques (65%), value addition (18.1%), and harvesting (11.3%). It was established that 72% of farmers grew *Eucheuma denticulatum* and only 1% grew *K. striatum*. Most respondents (67%) had 0 - 5 years of seaweed farming experience while only 2% had more than 15 years of farming experience. Among the farming inputs, ropes made up 39% of sponsored farming inputs, while tarimbo, pegs, drying racks, and post-harvest machines accounted for only 1%. According to 31% of respondents, most inputs were provided either by projects or the government, while self-purchase and NGO support accounted for 28% of supported inputs. Despite the developments observed in seaweed farming, a number of challenges hindered seaweed production that included; rising temperatures, strong winds, Elnino and pollution. Temperature increases accounted for 42% of the seaweed losses while pollution accounted for 5%. Farming of seaweeds was found to be year-round according to 70% of respondents. Overall, it was established that more capacity enhancement especially on restorative methods is required to ensure sustainability of the interventions in addition to mitigating on climate change effects.

RADiCOOL – COLD CHAIN ENERGY SOLUTIONS FOR SMALLHOLDERS

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Fish nourish over 10.2 million people in Uganda, supplied primarily from small-scale fisheries and increasingly from aquaculture. However, fish loss is 20-40%, primarily because of the lack of cold chain logistics. With aquaculture booming in Uganda, the need for 'first' and 'last mile' cold-chain transport equipment is critical in extending the shelf life of fish, reducing food waste, providing sustainable transport for food, improving livelihoods and creating economic opportunities within off-grid and weak-grid areas.

Current strategies have several limitations. While cooling solutions exist, they are too expensive for most potential users. Fish preservation methods such as drying can reduce the nutritional amino-acid profile of fish by up to 50%. Increasing fresh fish access has public health and wellbeing benefits, especially for women and children.

RADiCool uses Phase Change Material in various re-usable shapes to chill fish quickly and maintain temperatures within insulated boxes. The RADiCool technology was tested in a range of use-cases across the multitude of fish transporters who primarily use motorbikes to move fish from landing sites to market. It aimed to determine if the novel refrigerated transport solution could cut fish spoilage by extending the products' shelf-life, allowing vendors and customers longer to purchase a nutritionally valuable and highly desirable product.

There are three challenges that RADiCool trials set out to solve:

1. Traceability: The IOT tracking of temperature and location builds trust within the East African food supply chain and allows owners of perishable stock to ensure the quality, location and validity of their products.
2. Perishability: High value products such as fish are harvested in the early morning and may reach markets at midday. This presents a limited window of time to sell products on the same day by 7pm at the latest, to avoid fish spoilage. Our innovation allows fish sales to continue on the second day post-harvest and dramatically reduces the time pressure on sales. This significantly reduces spoilage and cost cutting by vendors.
3. Affordability: Most cold chain solutions available in East Africa are not viable for most potential users due to the dispersed nature of food markets and the limited role of large-scale retailers in the region. In Uganda, the country has a total of 348 supermarkets, 97% of which are single-owner operations and the remaining 3% belong to larger retail chains.

Can this appliance accelerate the ability of the fisheries and aquaculture industries to meet customer and producer's need for an affordable, efficient means to reduce fish waste in weak and off grid areas in East Africa? This solution is designed to be affordable to the mass fish market, increases post-harvest resilience and reduces environmental impact. Further piloting of this innovation will test viable business models that can enable 'last' and 'first' mile transport of fresh fish in East Africa.

EFFECTS OF DIFFERENT DIETS ON THE REPRODUCTIVE SUCCESS OF *Artemia franciscana* POPULATION IN KENYA UNDER LABORATORY CONDITIONS

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Artemia franciscana was introduced in Kenyan salt works in the early 1980s. The eight salt works along the Kenyan coast are credited for *Artemia* production since *A. franciscana* was first inoculated in Kenya about 4 decades ago. Genetically, the Kenyan *Artemia* is comparable to those from the Great Salt Lake and San Francisco Bay, which are considered as important live feed in aquaculture. In terms of reproduction, the Kenyan *Artemia* population (KAP) outperforms the original inoculants since it has adapted to the local environmental circumstances. However, information is lacking concerning reproductive success of the KAP when fed with different supplementary diets. One gram of *A. fransiscana* cysts was weighed and placed in a 2L plastic container with 1L of filtered seawater. The container was incubated for 24 h under continuous illumination and aeration. Hatched nauplii was fed with micro-algae until maturity, after which they were coupled in a ratio of 1:1 and stocked in 20 vials, 5 vials for each treatment. There were four experimental diets used: ALGAE 100%; Wheat pollard 100%;

Omena dust 50% + wheat pollard 50%; Omena dust 100%. Only males who died during the experiment were replaced, females who died, vial was discontinued for the duration of the experiment. The results revealed that the ALGAE treatment yielded the highest total production of cysts and nauplii. Notably, the results also indicated a synergistic effect in the group receiving the combined fish meal and wheat bran diet, which outperformed the separate Fishmeal and wheat bran treatments in terms of total cyst and nauplii production. The FM treatment (nauplii, cysts production) suggests that protein alone is insufficient to maximize nauplii production. Conversely, cyst production was highest in WB indicating a stress-induced reproductive strategy.

ADVISORY GROUPS: A STRATEGIC MODEL FOR ENHANCING COLLABORATION IN THE MANAGEMENT OF THE AFRICAN GREAT LAKES RESOURCES

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The African Great Lakes (AGL) harbor over 28% of the world's unfrozen freshwater, host the most biologically diverse fisheries in the world, and provide over 62 million people with food and livelihood support. The lakes: Albert, Edward, Kivu, Malawi/Niassa/Nyasa, Tanganyika, Turkana, and Victoria, are seeing increasing human populations and accelerating economic growth, leading to deteriorating conditions from pollution, over-extraction of natural resources, and agricultural intensification. Because each of these lakes is multi-jurisdictional in nature, shared by two or more of the ten riparian countries, and biodiversity-rich, enhanced interactions must take place between experts and decision-makers. Without shared efforts and defined collaboration frameworks, research is often disparate, and information not shared, leading to incomplete understanding of these resources and thus difficulty in properly managing these lakes. While regional efforts are being made to coordinate science and management, the African Center for Aquatic Research and Education was established to strengthen collaboration through a network of AGL freshwater experts. This network is realized through an Advisory Groups program, a model by which each lake's freshwater experts collaborate to ensure a more comprehensive understanding of their lake or basin, harmonize priorities, seek financial and research resources, and collectively work together to ensure the health of these lakes are well cared for.

This presentation aims to explore the experiences, lessons learnt, opportunities, ways forward, and solutions for further, successful future implementation of the Advisory Groups Program.

DYNAMICS OF MARICULTURE PRACTICES AND TECHNOLOGIES IN KENYA AND IMPLICATIONS FOR INTEGRATED MULTI-TROPHIC AQUACULTURE (IMTA)

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Globally, mariculture is gaining increased attention as a strategy to enhance food security, economic development, and environmental sustainability. Africa is increasingly recognizing the potential of mariculture especially in coastal regions to uplift livelihood and enhance food security. However, the sector remains underutilized across the continent due to technological, policy and social barriers. Despite the initial slugged development in Kenya,, mariculture is one of the key Blue Economy flagships aimed at supporting food security and improving livelihoods particularly for the low in society. Overall, the country has made notable strides in developing technologies and practices that simplify marine species cultivation. Data was collected in Kilifi and Kwale, Tana River, and Lamu county using purposive and random sampling through participatory approaches which included questionnaire survey A survey of mariculture stakeholders was undertaken to establish the diverse strategies and practices in use and how strategic they can be in advancing the Integrated Multi-Trophic Aquaculture (IMTA) agenda. The findings revealed that mariculture in Kenya is predominantly practiced by the youthful population aged 26 - 45 years (75%) with an average age of 39 years. It was established that aquaculture contributed more than 26% of the household incomes according to 59% of the households of the respondents and 56% involved family members in the aquaculture businesses. According to 97% of respondents, most marine aquaculture farms along the Kenyan coast have transitioned from extensive to semi-intensive farming. Furthermore the study established that 49% of the farmers practiced polyculture systems while 35% practiced monoculture. Finfish production dominates the sector (49%) with a small proportion (11%) engaged in seaweed farming. The primary species cultivated include milkfish (49%) and marine tilapia (43%) among other species like rabbitfish and mullets. Shellfish is largely driven by prawns which constitute the highest proportion (65%) followed for other species such as mud crab, sea-cucumber, lobster and oyster. Seaweed was dominated by *Eucheuma denticulatum* (83%). The technologies and practices employed, along with the willingness of the farmers indicated a positive response to adopting IMTA interventions. These could help diversify revenue streams while ensuring sustained environmental health. The transition towards IMTA integration systems presents a promising pathway for mariculture development to enhance climate-smart Blue Economy practices.

DOES CAGE CULTURE INFLUENCE PHYSICO-CHEMICAL PARAMETERS AND PHYTOPLANKTON DIVERSITY? A CASE STUDY ON ECOLOGICAL IMPACT OF CAGES IN LAKE VICTORIA KENYA

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The study was conducted to establish factors that influence phytoplankton diversity community structure in cages and there ecological implications. to human health. Sampling stations were selected in triplicates. Parameters determined include nutrients, phytoplankton chlorophyll and algal toxins. Phytoplankton diversity index was calculated by Shannon Wiener diversity index and phytoplankton richness calculated by Simpson richness Index. Statistical significance was set at $p < 0.05$. Statistical analysis was performed using Minitab version 17 Inc. for windows. There was a significant difference in chlorophyll *a*, temperature, dissolved oxygen, conductivity, pH and Secchi depth at Anyanga (ANOVA; $p<0.05$). However, no significant difference was observed in nutrients measured in Victory farm (ANOVA; $P>0.05$). Mean overall dissolved oxygen was 7.41 ± 1.39 mg/l and varied significantly between sampling stations ($p = 0.0491$). Mean conductivity levels was 142.39 ± 63.786 µS/cm, but differed significantly between stations ($p = 0.0005$). The mean phosphorus level was 330.02 ± 311.9 mg/l but differed significantly between sampling sites ($p = 0.001$). The mean overall ammonium level was 319.29 ± 397.35mg/l which was observed have varied significantly between sites ($p = 0.0008$). The mean overall Chlorophyll *a* level was 592.9 ± 604.38 mg/ l at Mfangano cages. At 46%, the Diatoms were the most predominant phytoplankton family in the study. There were significant differences in phytoplankton families between stations ($p = 0.0001$). Besides, the results can be used to rank the cages with respect to levels of pollution. High turbidity negatively affects the lake ecosystem hence proliferation of Cyanobacteria is likely to occur in cages, presently and in future with poor management practices.

UNDERSTANDING THE DRIVERS OF FISH FARMERS' MARKETING CHANNEL CHOICES: EMPIRICAL EVIDENCE FROM CAMEROON

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Although effective markets are crucial for improving farmers' livelihoods, aquaculture marketing channels remain poorly understood, especially in developing countries like Cameroon. This study uses cross-sectional data to analyze fish farmers' marketing channel choices in Cameroon. We find that elderly farmers, those who have participated in aquaculture training, those with extension contact, and those with access to market information are less likely to sell to fish traders than direct buyers. Furthermore, farmers who have experienced weather-related losses and who sell mostly in the rainy season are more likely to sell to traders. Compared to direct channels, the likelihood of selling to cooperatives increases with total output but decreases with the number of nearby farms. Male farmers and those who belong to cooperatives are less likely to sell to cooperatives. Improving extension services, developing market information systems and rural infrastructure, and strengthening cooperatives could help fish farmers to optimize their marketing strategies.

PROMOTING AFFORDABLE AND SUSTAINABLE CONVENTIONAL FEED ALTERNATIVES USING ACTIVATED MICROBES' FERMENTATION TECHNIQUES FOR SUSTAINABLE SMALL-SCALE TILAPIA FARMING IN TANZANIA

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High feed costs, presence of antinutritional factors, and poor-quality local feed ingredients are continuously limiting the sustainability of fish farming production and profitability of small-scale fish farmers in Tanzania. Good quality fish diet was produced through fermentation of a mixture of formulated local feed ingredients (39.3%) using activated Effective Microorganisms (EM) for 10 days before pelleted to produce high-quality fish diets (43.2% CP) that boosts fish growth and survival rates, while ensuring resilient environment. A 60-day an investigative experimental trial aimed to evaluate the effects of fermented (tested) and non -fermented (control) diets on growth performance and survival rate of Nile tilapia (0.43±0.06) g was conducted in an aquarium tank (each= 120 L). The experimental fish were aerated throughout the experimental periods. The growth curve of fish fed fermented gained weight almost doubled of the growth rate of fish fed non-fermented diet, refer fig.1.

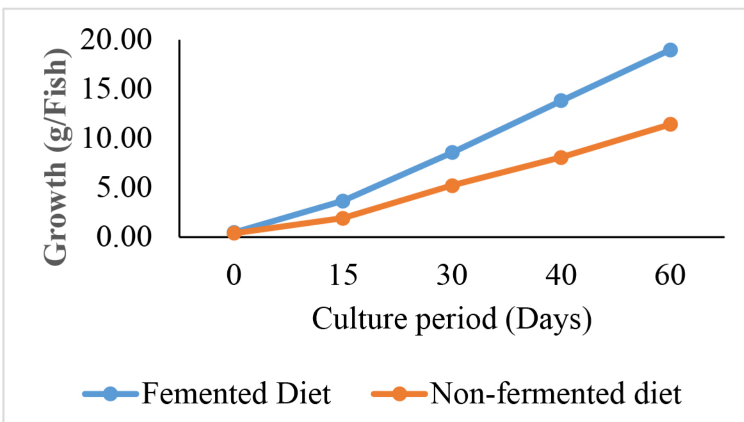

Figure 1: The growth curve of experimental fish fed dietary treatment

In addition, the results of dietary experimental trials indicated that there was a significant difference ($p < 0.0012$) between those fish fed fermented and non-fermented diets. The survival rate of the experimental fish in both control and test diets were 100%., while the condition factor (CF) was 1.86 for fermented diets, and 1.87 for non-fermented diets. The present findings clearly demonstrate potential of activated EM-based fermentation diets on improving nutritive contents of formulated fish diets, growth performance and survival rate of the cultured fish species. In addition, it has reduced dependence on expensive commercial feeds while improving fish health, growth, and financial returns.

ENHANCED GROWTH, HEALTH, AND MARKET GRADE OF NILE TILAPIA VIA OPTIMIZED MECHANICAL AERATION STRATEGIES: A COMPARATIVE EVALUATION IN CONCRETE PONDS

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Mechanical aeration is critical for maintaining water quality and enhancing fish productivity in intensive aquaculture systems. This study aimed to evaluate the efficacy of three aeration techniques (vertical turbine splash, fixed paddle wheel, and semi-movable paddle wheel) on Nile tilapia (*Oreochromis niloticus*) growth, blood biochemical parameters, water quality, and economic outcomes. Tilapia fingerlings (Initial weight: 70 ± 5 g) were reared in semi-rectangular concrete tanks (99 m^3) for 90 days under three aeration treatments (3 replicates each). Water parameters (dissolved oxygen [DO], temperature, total ammonia nitrogen [TAN], unionized ammonia [UIA]), growth performance (final body weight [FBW], feed conversion ratio [FCR], specific growth rate [SGR]), serum biochemical markers, and economic metrics (total revenue, benefit-cost ratio) were analyzed. The results revealed that the vertical turbine aerator significantly reduced UIA (0.017 mg/L) compared to fixed (0.047 mg/L) and semi-movable paddle wheel (0.042 mg/L; $P < 0.05$). While fixed and semi-movable paddles maintained higher DO levels (5.08–5.07 mg/L). The turbine system achieved superior growth rates (FBW: 310.3 g vs. 298.0–304.3 g; $P < 0.001$) and better FCR (1.406 vs. 1.428–1.446; $P = 0.049$). Additionally, the integration of condition factor (K) and length-weight relationship (LWR) analysis revealed superior somatic growth and health status under the turbine treatment, further supporting its biological and commercial benefits. Biochemical stress markers (e.g., glucose) were elevated in fixed paddle treatments, indicating potential stress from unidirectional water flow. Economic analysis showed no significant differences in profit margins, though the turbine system generated higher total revenue. In conclusion, vertical turbine aerators optimize water quality and growth efficiency, while paddle wheels enhance DO but may induce stress. Strategic aeration selection balances environmental, biological, and economic sustainability in tilapia farming.

EGYPTIAN RED TILAPIA IS A SOLUTION FOR PROVIDING FISH PROTEIN AMID THE NEGATIVE IMPACT OF CLIMATE CHANGE ON MARINE FISH PRODUCTION

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In light of the current challenges of climate change and unprecedented temperature rises, which have resulted in temperature fluctuations, increased salinity in groundwater, and rising prices of fish feed materials for the production of marine-farmed fish, Egypt has begun studying the acclimatization and breeding of hybrid red tilapia to produce high-quality, fast-growing fish that can withstand a wide range of salinity variations, ranging from 0 parts per thousand to 40 parts per thousand, with normal growth rates. Furthermore, these fish feeds contain tilapia feed with a protein content not exceeding 32% and a crude fat level not exceeding 7%. These fish feeds achieve FCR 1.2: 1, thus achieving a lower cost compared to the production of other marine fish species, such as sea bream and sea bass. This, in turn, provides fish protein at reasonable prices, given the challenges facing the world today.

AL-KERAM INTEGRATED AGRI-AQUACULTURE SYSTEM “KIAAS”

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This is a sucess storie of aquaculture production in the Egyptian desert reproduced below demonstrate the potential for farming commercial species using limited water resources. it highlight different aspects of the role that aquaculture can play in saving food security and contributing to local economic development through the generation of additional opportunities and revenues, thereby reaffirming the crucial contribution of the sector to blue growth.

The Egyptian Aquaculture sector is characterized by ongoing innovation of production systems, especially climate smart aquaculture to reduce energy, chemical fertilizer and water inputs. This is achieved through systems incorporating solar energy, water reuse and agricultural crop integration which reduces the carbon footprint of the sector.

This closed-loop ecosystem is called integrated Agri-aquaculture systems, which are now the key feature in Egypt to address water scarcity, climate change, and rising energy prices, while ensuring the provision of healthy food to citizens.

This system is annovated in Egypt since 1997 by the private sector and called:
Al-Keram Integrated Agri-Aquaculture system “KIAAS”.

FROM CATCH TO COMMERCE: EMPOWERING WOMEN AND YOUTH IN FISH PROCESSING THROUGH POST-HARVEST INNOVATION, BY-PRODUCT UTILIZATION, AND DIGITAL FINANCIAL LITERACY

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In sub-Saharan Africa, women and youth constitute a vital segment of the aquaculture value chain, particularly in fish processing and informal trading. Despite their role, these groups continue to face high post-harvest losses, lack of access to preservation technologies, and barriers to financial and digital tools necessary for business growth. This paper explores inclusive strategies to reduce post-harvest loss, promote by-product utilization, and improve financial and digital literacy among women and youth fish processors and traders.

Post-harvest fish losses in the region are estimated at 30–40%, stemming largely from inadequate infrastructure, poor handling, and limited access to value addition knowledge. Training in low-cost technologies such as hygienic handling, eco-friendly smoking, solar drying, and cold chain systems can significantly reduce waste and improve quality, leading to better market access and extended shelf life. By shifting focus to value addition and product quality, women and youth can increase profitability and gain formal market entry.

Additionally, fish by-products—heads, bones, skin, and entrails—are often discarded, yet they offer potential for the creation of new value chains in animal feed, organic fertilizer, cosmetics, and pharmaceuticals. This paper emphasizes the importance of skills transfer in by-product innovation, which not only reduces waste but also opens doors to micro-enterprise development.

Finally, integrating financial and digital literacy is essential for sustained empowerment. Access to mobile money, digital record-keeping, online trade platforms, and financial planning tools can help women and youth scale their operations, meet export standards, and engage in cross-border trade.

This paper proposes a multidimensional approach combining technical training, entrepreneurship development, and digital enablement. Strengthening these competencies can transform small-scale processors into resilient, market-ready players in Africa's growing blue economy.

A DEEP DIVE INTO THE STATUS OF THE FRESHWATER AQUACULTURE SECTOR OF SOUTH AFRICA

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The Department of Forestry, Fisheries and the Environment (DFFE), through its Directorate: Aquaculture Extension/Technical Services, provides technical support and advisory services to monitor and enhance the aquaculture sector, relying on accurate and timely data collection to assess its status, contribution to production volumes, and compliance with international reporting obligations. The marine aquaculture sector, which is governed through the Marine Living Resources Act (MLRA), provides for mandatory submission of production data by all permit holders operating mariculture farms on a monthly basis. On the other hand, submission of production data is not a legislated requirement for the freshwater aquaculture sector. Consequently, production data is submitted voluntarily and through several platforms such as producer organisations without input from the producers which has resulted in collection of inaccurate data. In order to close this gap, a study was conducted to assess, collect and analyse production data of freshwater farms within the nine (9) provinces. The assessment aimed to address the recording and monitoring the progress of the sector, providing reliable statistics and information to stakeholders, facilitating public awareness and finally to identify deficiencies in sector management.

Data was collected utilising the SurveytoGo platform and through physical site visits by an independent service provider. The findings of the study indicated a total of 188 responses received with more than 50% of survey respondents identified as small-scale fish farmers. The main freshwater species cultured is Mozambique tilapia (*Oreochromis mossambicus*), Nile Tilapia (*Oreochromis niloticus*), African sharptooth catfish (*Clarias gariepinus*), and Rainbow trout (*Oncorhynchus mykiss*). Primary systems of culture include ponds and Recirculating Aquaculture System (RAS), aquaponics and ponds. Key challenges experienced in the sector are unreliable source of electricity, market access, high input costs and competition from import market. The study produced reliable information and uncovered information that may guide support interventions by Government, particularly the small-scale aquaculture sector. In conclusion, continued efforts should be made between the DFFE and the freshwater aquaculture industry to further ensure the reliable data supply and address challenges identified in this study to promote sustainable development of the sector.

OPTIMIZATION OF NILE TILAPIA PRODUCTION IN EARTHEN PONDS *Oreochromis niloticus* A COMPARATIVE ANALYSIS AT DIFFERENT STOCKING DENSITIES

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Optimum density ensures sustainable aquaculture providing proper utilization of feed, maximum production, sound environment and health of all aquatic species. The main objective of this study was to compare Nile tilapia (*Oreochromis niloticus*) performance at different stocking densities and recommend the 'golden' stocking density in earthen ponds.

An experimental study was conducted to analyse survival rate, growth, harvest yield and fish welfare, from which nine square earthen ponds (each of 2500m^2) were used representing 3 treatments. SD_1, SD_2 and SD_3 being 8, 16 and 24 fish/m^2 respectively and each treatment was triplicated. Fish were fed floating feed and aeration was supplied to the earthen ponds with a 5% water exchange every second day. Water quality parameters (ammonia, pH, Temperature, Dissolved oxygen and turbidity) were monitored weekly, and sample weighing was conducted fortnightly to assess fish growth.

From the replications conducted, SD_3 (24 fish/m^2) had the lowest survival rate averaging 72% compared to SD_1 and SD_2 recording 100% and 97% respectively. SD_1 had a higher daily gram intake (G.I) and higher average body weight (ABW) than SD_2 and SD_3 recording 1.87-336g, 1.36-244g and 0.88-158g respectively. The most biomass per volume was realized in SD_2 averaging 2.54kg/m^3 followed by to SD_3 and SD_1 recording 1.87kg/m^3 and 1.81kg/m^3 respectively.

In conclusion it is observed that higher stocking densities does not equate to higher production as overstocking will have a negative impact on growth and survival rates in the cultivation of *Oreochromis niloticus.* Lower stocking densities however may result in better fish growth as seen in SD_1 (8fish/m^2) which may be preferred by farmers targeting bigger fish sizes. For farmers targeting to maximize production (biomass per volume or area) SD_2 (16/m^2) is the 'optimal middle grounded choice that strikes a balance between cost and benefit compared to the other two treatments.

Treatment	Total stock per Treatment	Total Recorded Morts	Total Counted Fish Harvested	Survival Rate (%)	F.C.R	Average Final Weight	G.I	Total Final Weight	KG/M3
SD1	60000	1040	60761	100	1.52	0.335	1.87	20340.17	1.81
SD2	120000	3691	116989	97	1.42	0.245	1.36	28606.77	2.54
SD3	180000	40805	129043	72	2.64	0.163	0.88	20996.75	1.87

Table 1. above shows totals and averages per treatment.

THE FINANCIAL AND PRACTICAL VIABILITY OF FEEDING BLACK SOLDIER FLY LARVAE WHOLE, LIVE DIRECTLY TO TILAPIA

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High costs of commercial feeds remain a key challenge affecting the viability of smallholder pond production in many regions of Sub-Saharan Africa. High feed costs result in farmers having to choose between not feeding their fish adequately or potentially running a loss due to high expenses. While fish feed availability and cost have reduced in recent years, a more affordable option is still needed for smallholder farmers to ensure commercial success.

Black Soldier Fly Larvae (BSFL) are voracious feeders of organic material, including decomposing animal and vegetable matter. They can, therefore, be used to convert wasted and spoilt resources into usable protein for feeds. Black Soldier Fly (BSF) are therefore being explored globally as an alternative source of protein for animal feeds. There are numerous challenges with this objective of using BSF as protein replacement in animal feeds. These include high labour costs, large volumes of waste aggregation and high cost of BSF processing into meal. Thus, their application for large-scale operations is limited.

RAD (a smallholder focused fish farm service provider in Uganda) has pioneered a novel BSFL-as-feed approach that circumvents these challenges, enabling smallholder farmers to achieve economic growth performance. The approach sidesteps the processing requirements for BSF, by feeding live BSFL to fish in ponds. A trial in partnership with the ThinkAqua examined how live BSFL feed would affect fish growth. This trial was conducted in fertilised ponds at the RAD farm in Rukungiri, Uganda, to evaluate different feeding strategies to optimise fish growth. A total of 100 fish were stocked in hapas and subjected to four different feeding treatments. The treatments included no feed (NF), commercial feed only, 33% substitution of commercial feed with BSFL, and 66% substitution of commercial feed with BSFL. Over the trial period there was no reduction in growth between fish fed on commercial pellets or those fed with substituted BSFL.

Based on the results of this trial, RAD scaled their BSFL production and now produces fish with a BSFL substation rate of 80%. In addition, RAD breeds and rears BSF (the more operationally challenging stage) and sells the BSFL to smallholder farmers. BSFL production is possible by smallholder farmers to support their own pond production, requiring only a source of organic waste, a small area to grow the BSFL, and low daily labour requirements. Smallholder farmers can focus on the relatively simple challenge of growing their BSFL at the current price point of $0.70 per kg. This compares favourably to the market price of $1.30 per kg for commercial pellets. Thus, an 80% inclusion of BSFL offers over 36% reduction in feed costs. This approach provides a strong incentive for farmers to adopt this approach as it significantly reduces their production costs, while considering the local contextual challenges in which they operate.

A B Cs IN MARICULTURE DEVELOPMENT IN KENYA. LESSONS FROM COMMERCIALIZATION OF SEAWEED FARMING

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Kenya Marine and Fisheries Research Institute

To enhance the blue economy and provide both food security and livelihood opportunities, sustainable mariculture ventures have been undertaken and supported by both government and non government actors. Commercialization of Seaweed mariculture in the South Coast of Kenya has been successfully achieved. Since 2010, commercial seaweed farming has been practised in the South coast of Kenya thereby contributing to a community-driven sustainable blue economy. The success in commercialization of seaweed farming was contributed by the high demand for seaweed products in the international market, scientific guidance into the development of the venture, good support from the county and national government and non-government actors (NGO) and a willing community of farmers in the South Coast of Kenya. This work highlights the successes achieved in commercial seaweed farming in the South Coast of Kenya. We highlight the challenges and discuss the overall contribution of commercial seaweed farming in Kenya. Further, we highlight the missteps and challenge the methodology applied by the various stakeholders in their contributions to developing seaweed commercialization. We also report on the results from analyzing sixteen years seaweed production and sales data from Kibuyuni and use the results to initiate a discussion on the need of a change in strategy by the various stakeholders.

UNRAVELLING THE CAUSES OF THE CURRENT WILD FISH KILLS IN KISUMU BAY FISHERY OF LAKE VICTORIA, KENYA

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Recurrent fish kills in Kisumu Bay, Lake Victoria, Kenya, threaten both ecological stability and local livelihoods. These events have been linked to eutrophication, harmful algal blooms, and declining water quality driven by deforestation, urbanization, and industrialization. Historical and recent incidents including major fish kills in 1984, 2022, and 2024, highlight the role of low dissolved oxygen, toxic runoff, and climate-related impacts, resulting in significant economic losses. In response to a recent spike in reported cases, this study seeks to identify the underlying causes of fish mortality in Kisumu Bay and propose suitable mitigation measures. Field surveys and water quality analyses were conducted across key sites, including the Kisat River mouth, Coca-Cola discharge zones, and a designated control station. This study investigates the drivers of recent fish mortality events through field surveys and water quality analysis across key stations, including Kisat River mouth, Coca-Cola discharge zones, and the control station.

Results revealed severe hypoxia (dissolved oxygen [DO] < 2.5 mg L^{-1}), far below the 6–8 mg L-1 threshold required for fish survival, alongside hyper-eutrophic conditions marked by elevated ammonium (NH4+ > 1.5 mg L^{-1}), total nitrogen (TN > 40–50 µg L^{-1}), and phosphorus (TP >700 µg L^{-1}). Chlorophyll-*a* concentrations exceeded 100 µg L^{-1}, indicating prolific algal blooms linked to nutrient overloading, possibly from industrial effluents, agricultural runoff, and untreated sewage. Spatial-temporal analysis identified the lowest DO levels during algal decomposition phases, exacerbated by an oil layer near docking sites, which could have impeded gas exchange and coated fish gills, intensifying respiratory stress. Nitrite peaks (21.12 mg L^{-1}) and ammonium spikes signalled toxic pollution from wastewater, while Secchi depth measurements inversely correlated with algal biomass, confirming turbidity-driven hypoxia.

The study attributes fish kills to possible synergistic effects of nutrient pollution, climate-driven temperature rises (27.26°C on average), and inefficient waste management. The study recommends enforcing industrial effluent regulations, expanding wastewater treatment infrastructure, and reclaiming wetlands to mitigate runoff. This work provides a framework for addressing eutrophication-driven fish mortality in tropical freshwater ecosystems, advocating for integrated watershed management to sustain Lake Victoria's fisheries and socio-economic resilience.

CHALLENGING GENDER NORMS AND GENDERED TABOOS: WOMEN'S ECONOMIC RESILIENCE TO CLIMATE CHANGE IN THE FISH VALUE CHAIN

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Women struggle to build their economic resilience to climate change challenges such as excessive rain, drought and too much heat that reduce productivity and threaten food security and access to basic needs. This is partly because of gender norms and gendered taboos that restrict their activities and choices when developing coping strategies. However, women and men are increasingly challenging these discriminatory norms. Using case studies of fish value chains from Ogun State, Nigeria and Muleba District, Tanzania, this paper addresses the question: what insights do women's and men's motives and approaches for challenging discriminatory gender norms and gendered taboos offer when considering how to accelerate transformative processes to increase women's ability to build resources for economic resilience in the face of climate change? Data was collected using interviews and sex-disaggregated focus group discussions. A combination of the realist theory of hegemony, theories on the hegemony of men and African feminist thought was used to frame the fishing communities as spaces of contestation where men's hegemonic power is constantly challenged as men and women interact with each other and their community's structural conditions. Our study finds that persistent economic difficulties, caused partly by climate change challenges, have made men and women more open to social change and building alliances across genders. Women and men are increasingly challenging discriminatory gender norms and gendered taboos by consciously breaking them. We conclude that it is vital to understand what motivates community members who challenge gender norms and gendered taboos and those who do not. These motives may be key to accelerating gender-equal transformation. This is because the motives offer insights into promoting critical and inclusive community engagement and home-grown sustainable solutions by identifying key levers for building alliances across genders, such as the need to combine forces to address economic and climate change challenges.

A META-ANALYSIS OF PRODUCTION VOLUMES IN NEW AND INNOVATIVE AQUACULTURE SYSTEMS AND PRACTICES IN AFRICA: TRENDS, AND FUTURE POTENTIAL

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Aquaculture is increasingly positioned as a critical pillar of Africa's food security strategy, especially amid declining capture fisheries, population growth, and climate-related shocks. While traditional pond and cage systems remain dominant, innovative aquaculture technologies such as biofloc, recirculating aquaculture systems (RAS), aquaponics, and integrated multi-trophic aquaculture (IMTA) are gaining traction across the continent. These systems promise higher productivity, improved feed efficiency, and reduced environmental impacts. However, systematic evaluations of their actual performance and scalability in African contexts remain limited. This study conducts a meta-analysis of 52 published and grey literature sources, assessing production volumes across RAS, biofloc, aquaponics, and IMTA systems in Africa. Yield data were standardized to kilograms per cubic meter per year (kg/m³/year), with pooled means and heterogeneity measures calculated to determine relative performance.

RAS emerged as the most productive system (mean: 79.3 kg/m³/year; FCR: 1.3), followed by biofloc, IMTA, and aquaponics. Species-specific productivity and moderating variables—such as feed quality, training access, and species-system compatibility—were also analyzed. Using a logistic growth model, the study projects future yields under three scenarios: business-as-usual, moderate improvement, and high improvement. Under the high improvement pathway, yields could exceed 120 kg/m³/year in countries with strong institutional support and infrastructure. Findings demonstrate the significant performance advantages of innovative systems over traditional methods, while highlighting the critical role of contextual enablers. The study concludes by recommending strategic investments in input subsidies, training, research, and public-private partnerships. These measures are essential to scale sustainable aquaculture technologies and position the sector as a cornerstone of Africa's blue economy.

PRESERVATION AND PROFITABILITY OF VALUE-ADDED FARMED NILE TILAPIA *Oreochromis niloticus*, Linnaeus 1758 IN MBARARA CITY, UGANDA

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To increase revenue and access to market for farmed fish in small holder fish farmers, assessment of fish preservation methods and profitability of value-added products was conducted in Mbarara City markets. The objectives were to determine the major fish value addition techniques and the net profit margin (%) of producing value-added farmed fish products using the dominant technique. A cross sectional survey was used to determine the dominant fish preservation techniques while a case study trial was used to determine the profitability of value-added farmed fish. Results showed that hot smoking was the dominant fish preservation technique followed by frying and slow freezing. Value addition by further processing of smoked fish into fish powder increased net profit from fresh fish by 46% (from Ugx. 87,500 (33.3 % Net Profit Margin) for every 25kg to 163,000 (37.5% Net Profit Margin) after sell of products within local markets. It was concluded that preservation by smoking was the most preferred fish preservation technique and subsequent value addition/processing made the fish farming enterprise more profitable in Mbarara city. It was recommended that preservation and value addition to farmed fish should be adopted among fish farmers, small scale fish processor and prospective investors to increase access to premium markets and profit margins.

Table 1: Profit indices in fresh fish, smoked fish and fish powder

Description	Fresh fish	Smoked fish	Fish powder
Quantity	175 heads	175 heads	3.5kg
Buying price (Shs)	1000	1000	233,750
Cost of value addition (Shs)	0		40,800
Total cost (Shs)	175000	233,750	274500
Selling price (Shs)	1500	2000	125,000
Total revenue (Shs)	262500	350000	437500
Gross profit (Shs)	262,500	350000	437500
Net profit (Shs)	**87,500**	**116,250**	**163,000**
Profit margin (%)	**33.3**	**33.2**	**37.3**

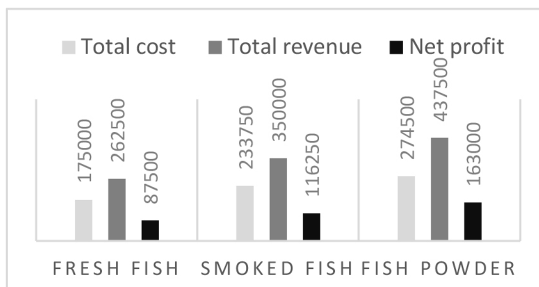

Figure 1 Variation in costs, revenue and net profit among different products of farmed fish

GENETIC BACKGROUND OF GROWTH AND SEX DETERMINATION IN INDIGENOUS FARMED STRAINS OF NILE TILAPIA (*Oreochromis niloticus*) IN UGANDA

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Nile tilapia is the most important aquaculture species on the African continent, providing high-quality nutrients, and a major source of income to sustain the livelihoods of many people involved in the supply chain on the continent. This species is native to Africa, however, the genetic background of key traits in the indigenous strains on the continent is largely unknown which limits the genetic improvement of these strains for better production.

In the current study, ~600 juvenile fish produced from a commercial Nile tilapia hatchery broodstock population (originally sourced from Lake Albert, Lake Kyoga, and Lake Victoria) were evaluated for growth. Fish were tagged at ~3 months of age and body weight and morphological traits were measured biweekly. Fin clip tissues were collected for 500 fish and subsequently genotyped for 27 M variants (SNP and INDELs) via low-coverage sequencing and imputation. Genotype data was cleaned of variants with low minor allele frequency (maf < 0.05) and those that significantly deviated from Hardy-Weinberg Equilibrium (HWE, P < E-7), clean genotype data was subsequently used to perform principal component analysis (PCA) and genome-wide association study (GWAS) analyses for average daily gain, body weights, and sex.

In the current study, a total of 499 fish had good-quality genotype data (5.4M SNP and INDELs). Fish from the three stocks did not significantly (P > 0.05) differ in growth, but L. Albert stock grew faster (0.58g/day) than the stocks from L. Victoria (0.57g/day) and L. Kyoga (0.54g/day). In all three sub-populations, male fish grew significantly (P < 0.05) faster than the females. Despite being kept together in the same pond without tagging, PCA results showed substantial genetic differentiation between the three sub-populations kept by the hatchery (**Figure 1A**). GWAS results showed generally polygenic architecture for growth rate (**Figure 1B**) and body weight, however, we identified three major quantitative loci (QTLs, 2 on Chromosome 6 and 1 on Chromosome 23) underlying sex determination in the studied Nile tilapia populations (**Figure 1C**). Our results are a resource contributing towards improving tilapia production.

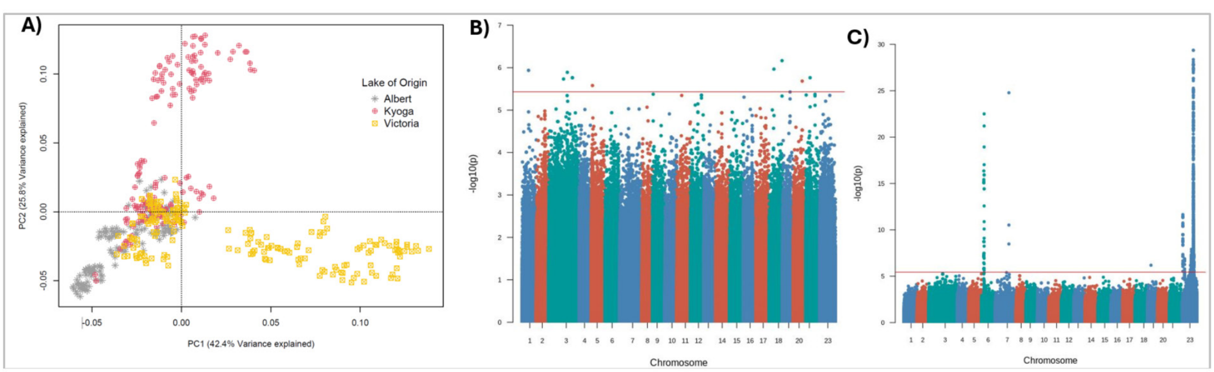
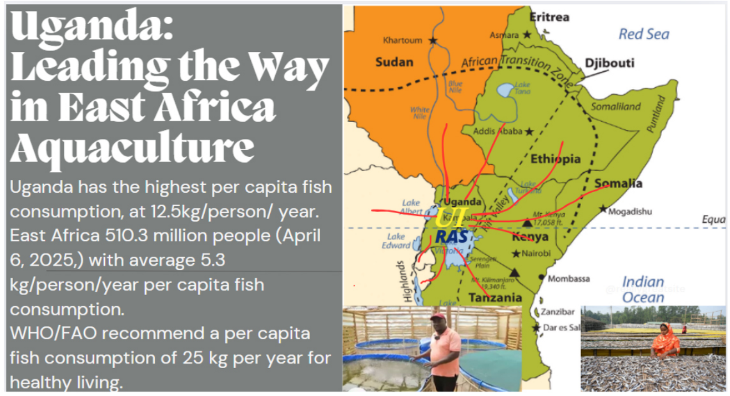


***Figure 1**: **A)** Principal component analysis plot showing the genetic structure of the studied population; **B)** and **C)** Manhattan plots of the GWAS for ADG sex determination respectively.*



AFRICA'S SUSTAINABLE FISH FARMS: **UI-RAS FLOCPONICS** HYBRID SYSTEM FOR ENHANCED POND PRODUCTIVITY.

Author: Charles Mulamata* CEO
As presented in 3rd UN FAO Symposium, CACANA, Email: infomarkc5@gmail.com

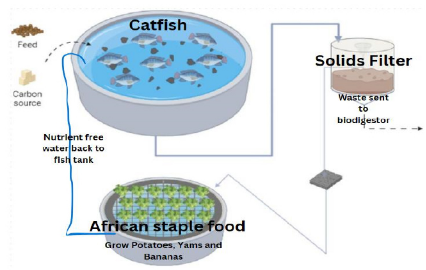
Fig1: East Africa Proposed UI-RAS FlocPonics deployment: (Kanya, Tanzania, Rwanda, Burundi, Ethiopia, Somalia, Sudan, DRC)

Introduction: Pearl of Africa, Uganda, premier tourist destination, #1 producer in EA the fastest growth node for aquaculture & #3 In Africa boasts a substantial aquaculture infrastructure, with over 25,000 av 500m² ponds. However, the current productivity of these earthen ponds, at approx 3.8t/y, falls short of Uganda's aquaculture potential, does not meet its current demand and won't achieve its ambitious 2030, 1M tons/Y target.

Here, I present how **UI-RAS FlocPonics** hybrid systems can integrate with ponds to transform & unlock commercial viability by dramatically increasing national aquaculture output to meet set targets with minimal additional investment.

Total	120,000	100%	2023 Y
Pond	96,000	80%	Av 3.8t/pond/y
Cage	18,000	15%	
Tank	6,000	5%	

If in 2023 Uganda produced 120,000T/Y, and our **PoC UI-RAS FlocPonics gives 6 tons/year in 64 m², then** a **500 m² hybrid modified pond system has potential to produce** 46.8t/y, or 1,171,875 t/y from 25K ponds.



The Challenge: Lack of knowledge, Traditional earthen pond limitations, Low stocking density, Environmental Vulnerability, long gestation and high FCR.

Solution: UI-RAS FlocPonics Hybrid System has knowledge to leverage existing pond infrastructure, harness the potential of African catfish species to increase productivity and create wealth for the community. On this **World Aquaculture Safari 2025 event**, we request the addition of Aquatourism on the Tourist circuit.

Better Water Quality, low FCR, Nutrient Recycling, Increased Stocking Density, Reduced Water discharge and Loss.

Economic and Environmental Benefits):

Sludge: UI-RAS FlocPonics collects sludge, bio-digests it and the slurry is composted to make e-coli free high value organic vegetable fertilizer.

The 4 month season gives 3 cycles a year, lower FCR. The use of less protein in feed drastically reduces costs and increases profits.

Minimal Investment: No need for extensive new infrastructure development.

Call to Action: Collaboration with government, development partners, Research/financial institutions to implement this to support smallholder farmers to meet Govt. set targets.

Visit: UI-RAS FlocPonics PoC in Budo**.**

UNLOCKING AQUACULTURE POTENTIAL OF ARID AND SEMI-ARID LANDS IN KENYA FOR FOOD SECURITY AND ECONOMIC GROWTH

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This review explores the untapped aquaculture potential in Kenya's arid and semi-arid lands (ASALs), highlighting the region's underutilized aquatic resources, including rivers, lakes, and dams. Despite Kenya's substantial water resources relative to top aquaculture producers like Egypt, aquaculture development in ASALs remains minimal, even though these regions cover 89% of the country. The study assesses ASAL water resource suitability for aquaculture, identifies key challenges, and proposes actionable solutions, drawing lessons from Egypt's successful aquaculture sector. A narrative literature review synthesizing high-quality scientific and grey literature was conducted. Findings reveal that ASALs possess significant aquaculture potential due to their favorable climate for species like Nile tilapia and African catfish, permanent rivers such as the Tana and Athi, and large reservoirs like the Seven Forks Dams. However, challenges such as water-level fluctuations, pollution, wildlife interference, stakeholder conflicts, and financial constraints hinder aquaculture development. The study highlights policy frameworks, financing models, and best practices from Egypt that Kenya could adopt to strengthen its aquaculture sector in the ASALs. It underscores the importance of integrated water management, stakeholder collaboration, and investment in capacity-building initiatives. Innovative approaches such as cage and pond aquaculture, supported by policies and infrastructure, are crucial for unlocking aquaculture's transformative potential in Kenya's food systems and rural economies. This review offers valuable insights for policymakers, researchers, and investors to advance aquaculture as a sustainable, scalable solution for economic growth and food security.

VERTICAL INTEGRATION VS. INFORMAL AGREEMENTS: EVALUATING THE IMPLICATIONS OF CONTRACT MODELS IN COASTAL FISH FARMING

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Coastal aquaculture's growth may also hinge on contract farming models which can aid in poverty reduction, improvement of food security and promotion of economic growth. However, concerns persist regarding inequitable conditions, sustainability shortcomings, and the absence of inclusive models designed to enhance productivity and market access. The absence of a robust governance framework to regulate these models at the community level is apparent, necessitating improved institutional mechanisms to protect vulnerable farmers. As such, the specific contractual arrangements established must be carefully structured to safeguard farmers from exploitative dependencies and systemic inequities.

A comparative case study approach was conducted where purposive sampling was adopted targeting contracted and non-contracted farmers in mariculture in coastal counties (Kwale and Kilifi) of Kenya. Mixed Methods with both quantitative and qualitative data collection was applied. Literature review was conducted of existing regulations supporting or hindering contract models in aquaculture development. Semi-structured questionnaires, focus groups, key informant interviews were conducted to gather information from the farmers and various stakeholders. Some of the indicators used for evaluation included: income, access to inputs, soft loans, production, market linkages, conflicts and dispute resolution mechanisms, land tenure security and benefit sharing.

Preliminary results indicate that both production and marketing contracts were in existence where farmers sited advantages for instance, exposure to targeted skill development, credit and inputs access, guaranteed markets and prices among others. However, while vertical integration was offering quality control and market access it was at the same time reducing the farmers autonomy; whereas the informal agreements were providing flexibility and low barriers but were at the same time exposing the farmers to scaling challenges. Additionally, the investors reported that frequency of contract breaches was high, lack of dispute resolution mechanisms, and insurance access among the farmers.

At a preliminary stage, the study proposes for adoption of the middle path for Hybrid models where the strengths of vertical integration and the flexibility of the informal agreements put into consideration as an emerging pathway for sustainability. Additionally, there is need for a clear framework of contract enforcement and empowerment of the local farmers in collective bargaining. Policymakers also need to promote fair, sustainable, and inclusive contract models to maximize benefits while minimizing risks.

INNOVATIVE PUBLIC–PRIVATE PARTNERSHIPS FOR AQUACULTURE DEVELOPMENT IN SUB-SAHARAN AFRICA

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Aquaculture in sub-Saharan Africa (SSA) holds great promise for improving food security, creating employment, and driving rural development. However, the sector remains underdeveloped due to persistent challenges such as limited access to finance, inadequate infrastructure, and weak institutional frameworks. This presentation highlights findings from a recent FAO technical paper that explores how public–private partnerships (PPPs) can serve as an innovative mechanism to overcome these constraints and catalyze sustainable aquaculture growth in the region.

Drawing on case studies from Uganda, Ghana, and East Africa, the study categorizes PPPs into three main types: partnerships for innovation, technology, and knowledge transfer; partnerships for aquaculture value chain development; and partnerships for infrastructure development. Examples include laboratory testing services to meet export standards, integrated value chain models, and the innovative use of public wastewater infrastructure for fish production.

The paper also examines the legal and governance frameworks enabling PPPs in aquaculture and identifies critical gaps that hinder their effectiveness, such as regulatory ambiguity and financing constraints. It concludes with actionable recommendations for governments, private sector actors, and donors to create enabling environments, design scalable PPP models, and invest in innovation and infrastructure tailored to small- and medium-scale aquaculture enterprises.

This work underscores the need for multi-stakeholder collaboration to unlock the full potential of aquaculture in Africa through responsible, inclusive, and results-oriented PPPs.

ESTIMATION OF NUTRIENT LOAD IN THE WASTES OF NILE TILAPIA REARED IN CAGES AND FED SOYBEAN MEAL-BASED DIET SUPPLEMENTED WITH DIFFERENT LEVELS OF PHYTASE ENZYME

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With the rapidly increasing trend of cage fish farming in freshwaters, practices to enhance fish farming sustainability are increasing. We estimated how different levels of phytase enzyme (0, 500, 1000, 2000, 4000 FTU kg^{-1}) affects the growth performance and nutrient load of tilapia (5.2 ± 0.1 g) reared in 15 cages for 180 days. The experimental design followed a completely randomized approach, with three replicates. The most significant increase in growth was observed in the groups that were given a diet supplemented with phytase at 4000 FTU kg^{-1} of feed. These groups reached a slaughter size of 420.2 ± 6.6 g and experienced weight gain approximately three times greater than the control group (final weight: 146.8 ± 4.8 g). The phosphorus and nitrogen load for groups that were given diets with a phytase supplement of 4000 FTU kg^{-1} of feed were 54% and 32% lower, respectively, compared to the control group and other diets that were supplemented with phytase. Hence, it is advisable to add phytase at a concentration of 4000 FTU kg^{-1} feed in order to improve the growth performance and increase the availability of nutrients, while also minimizing waste in the cage culture of tilapia.

EVALUATION OF THE IMPACT OF WARM RAINY SEASON AND POLYTHENE POND COVER ON GROWTH, REPRODUCTION, AND FITNESS OF *Oreochromis Niloticus* AND *Oreochromis Aureus* IN KENYAN COLD HIGHLANDS: A GENOTYPE-BY-ENVIRONMENT INTERACTION STUDY

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This study aimed to investigate the interactive effects of genotype, warm rainy season and polythene pond cover on the growth, reproduction of *Oreochromis niloticus* and *Oreochromis aureus* in the Kenyan cold highlands. *Oreochromis niloticus* and *Oreochromis aureus* growth, face challenges due to the harsh climatic conditions. Ponds were established, each housing a specific genotype of *O. niloticus* and *O. aureus*. Half of the ponds were covered with polythene cover to simulate a controlled environment, while the other half were exposed to open environment. The ponds were monitored throughout the warm rainy season to assess growth rates, reproductive success and overall fitness. *Oreochromis niloticus* and *Oreochromis aureus* showed different results to the warm rainy season and polythene pond cover while *O. niloticus* thrived in the natural environment, other performed better under polythene cover. Similarly, *O. aureus* genotypes showed varying growth and reproductive rates depending on the season and pond cover.

This study provided valuable insights into the adaptive measures of *O. niloticus* and *O. aureus* in the Kenyan cold highlands thus considering genotype-by-environment interactions in aquaculture practices and conservation efforts. Challenges affecting growth and reproduction targets breeding programs and pond management strategies that can be developed to increase production cold environments.

AN ASSESSMENT OF THE KNOWLEDGE ATTITUDE AND PRACTICES (KAP) ON BIOSECURITY AND BEST MANAGEMENT PRACTICES IN NILE TILAPIA (*Oreochromis niloticus*) CAGE AQUACULTURE IN LAKE VICTORIA, KENYA

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As aquaculture intensifies, maintaining conducive conditions for sustainable production becomes a key priority. The expansion in farm number and per farm production puts pressure on the environment and increases susceptibility of the cultured fish to disease, leading to production loss by the investors. This study was conducted in cage aquaculture systems located in three riparian counties in Lake Victoria, Kenya to investigate the combined role of biosecurity and adherence to best management practices (BMPs) by looking at the knowledge, attitude, and practices (KAP) of the cage aquaculture farmers. Additionally, it examined the link between biosecurity, BMPs, and water quality in the context of promoting fish health and preventing fish kills in the cage aquaculture of Nile tilapia in Lake Victoria, Kenya. Gulf and open water locations were included in the study design. A semistructured questionnaire was used to gather qualitative information on the KAP of fish farmers to biosecurity and BMPs in the cage aquaculture farms. For water quality analysis, quantitative data was utilised. Results showed that the farmers had a positive attitude towards various biosecurity and BMP concepts and a moderate level of knowledge, but the practices on the farm were not in concurrence with both their attitudes and knowledge. Using a customised aquaculture performance index score, which assessed compliance to some BMPs and biosecurity, only 8% of the farms under investigation had a good score, while 24% had an average score and the majority (68%) had a poor score. Additionally, a good aquaculture performance index score was inversely related to ammonia levels. This finding suggests the need to locate cage fish farms in areas with better water circulation. The study highlights the need for capacity building on the importance of adherence to biosecurity and BMPs in the cage aquaculture of Nile tilapia in the lake for enhanced productivity and sustainability of the lake ecosystem.

EFFECTS OF PHYTOPLANKTON ON WATER QUALITY DYNAMICS ON NILE TILAPIA IN EARTHEN PONDS AT NYAGUTA FISH FARM IN KISII COUNTY

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Aquaculture is the future bridging gap for the declining capture fisheries. Fish farming in Kenya is currently on the increase according to recent overview survey in Kenya. In the effort to increase production in ponds there was need to investigate the water quality and algal biodiversity since they play a good role in the aquatic food chain. An investigation, carried out from October 2015 to 2018 showed that Physico-chemical parameters (turbidity, temperature, conductivity, alkalinity, dissolved and suspended solids, and dissolved oxygen concentration) were measured insitu. Chlorophyll *a* and phytoplankton analyses were done using spectrophotometric and microscopy techniques respectively. There were significant spatial differences in the dissolved oxygen concentrations ($p<0.0001$) within the ponds. These differences were pronounced at the Pond B, Pond E and Pond F respectively. The differences were associated with the stocking density and feeding regimes. Chlorophyll *a* concentrations were found to be higher during the dry season compared to the rainy season. This could be attributed to high turbidity during the rainy season, which reduces light penetration into the water column. Diatom family 60 %, and was the most abundant group followed by Chlorophyceae (28%), Euglenophytes(11%), Zygnemetaphaceae family (7 %), Euglenophyceae (4%) and Cyanophyceae. Among the diatoms the most dominant species were *Amporas* sp., *Cyclotella* sp., *Synedra* sp and *Surillella* sp. Significant differences in distribution patterns in phytoplankton were observed between the Pond A to Pond F. Phytoplankton quotient (PQ) value was estimated at 4.1 ± 0.26 indicating that the ponds is highly eutrophic. These results are useful in the formulation of management advice to stakeholders**.**

EVALUATION OF A PILOT AQUAPONICS TECHNOLOGY DEVELOPMENT AND INNOVATION TRANSFER PROGRAM IN INSTITUTIONS OF LEARNING ACROSS THE COUNTRY: IMPLEMENTATION STATUS, PERFORMANCE ANALYSIS, AND STRATEGIC LESSONS

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This study reviews the establishment, benefits and operation of aquaponic demonstration units in 55 Kenyan learning institutions which took place during fiscal years 2017 to 2021. Supervised by the National Aquaculture Research Development and Training Centre (NARDTC), the initiative looked at how aquaponics can be used together as a combined approach for sustainable agriculture that includes aquaculture and hydroponics. Experts used on-the-spot demonstrations, visits to the sites, progress assessments, interviews with those involved and photos to carry out the research.

An approach that uses both qualitative and quantitative methods was used. Using tracking at all sites, we found that 82% were up and running, 5% were stalled or not done completely due to different problems, 2% were partly completed and 11% were brand new constructions yet to be assessed. Studying local reports brought up constraints that included problems with vandalism, difficulties with water and logistical issues. Issues such as vandalism and problems with the water supply made it difficult to carry out planned actions at Wachoro Secondary School and Wiyumiririe High.

It adds to our knowledge of sustainable food systems by using data from sub-Saharan Africa. In aquaponics, you can produce both aquatic foods and organic vegetables, using less water and space. It is shown in the study that aquaponics can play a role in making food more accessible, giving jobs to youth and conserving the environment. Integrating it into schools proves that it helps advance education and connects students with the community.

It is advised to increase teamwork between the public and private sectors, raise spending on infrastructure and expands support for youth and smallholder farmers' training. This plan expressly matches Kenya's Vision 2030 targets concerning food supply, new technologies and caring for the environment. The study proves that aquaponics can strongly benefit Kenya's agriculture and education if there is proper skill training and resource support.

Summary Table: Aquaponic Units Implementation Status

Status	Number of Institutions	Remarks
Complete	45	Fully operational and functional units
Partially Complete	1	Limited implementation (e.g., Lenana High)
Incomplete/Stalled	3	Due to vandalism or water issues
New (2020/2021 Phase)	15	Recently initiated, status developing
Not Reported/Blank	9+	Status unspecified in the report

MORPHOMETRIC AND GENETIC VARIATION OF FARMED AND WILD NILE TILAPIA *Oreochromis niloticus* ACROSS UGANDA'S AGROECOLOGICAL ZONES: IMPLICATIONS FOR SEED SOURCE SELECTION

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This study investigated factors influencing farmers' choice of seed or broodstock sources and analyzed morphometric and genetic variation in farmed and wild *Oreochromis niloticus* (Nile tilapia) across Uganda's agroecological zones (AEZs). Data were collected from 221 fish samples, sourced from 15 farms and four major lakes; through semi-structured farmer interviews, morphometric imaging, and fin clip sampling.

Principal Component Analysis (PCA) and Canonical Variate Analysis (CVA) were used to identify shape variation and population differentiation based on morphometric traits. Genetic variation was assessed by sequencing the mitochondrial DNA D-loop region, with genomic DNA extracted at Makerere University and sequencing conducted at NRF-SAIAB.

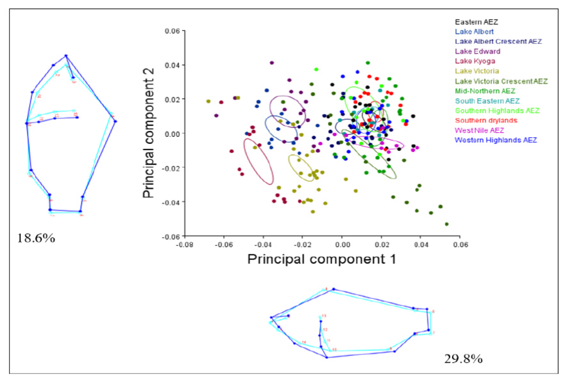

Figure 1: PCA for AEZs and lakes.

Results showed that 50% of farmers sourced seed from the Lake Victoria Crescent AEZ. Significant shape divergence was detected among populations for principal components 1 and 2 ($P < 0.05$). Genetic analysis revealed high haplotype diversity ($Hd = 0.864$) and low nucleotide diversity ($\pi = 0.009$), with phylogenetic analysis grouping populations into four distinct clusters.

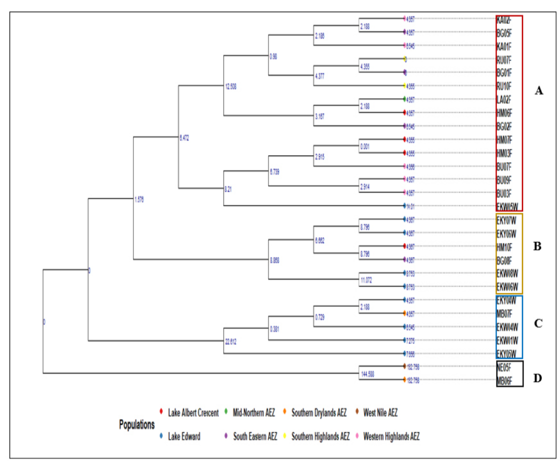

Figure 2: phylogenetic tree of *O. niloticus* populations based on haplotypes from the mtDNA D-loop region.

The findings suggest that environmental differences across AEZs, particularly temperature, may drive both morphometric and genetic divergence; hence, influencing the growth and performance of *O. niloticus* in aquaculture systems. To ensure optimal productivity and minimize ecological risk, the study recommends regulating fish translocation and promoting the use of genetically and morphologically suited broodstock.

PROMOTING SUSTAINABLE AQUAPONICS IN UGANDA USING LOCALLY AVAILABLE MATERIALS

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Aquaponics is an integrated system combining aquaculture and hydroponics that recycles fish waste into plant nutrients, enabling sustainable food production with minimal land and water (Rakocy et al. 2006; Somerville et al. 2014). In Uganda, rapid urbanization, climate stress, and shrinking farmland have undermined traditional agriculture and aquaculture (FAO 2020). Emerging pilot projects demonstrate promise, yet high startup costs and dependence on imported components limit aquaponics adoption (Okello *et al*. 2020). This study investigated small-scale system built from locally available materials, assesses their costs, and market potential for fish and vegetables.

Methods: A model unit was assembled using a 1000 L plastic tank, 200 L drum reservoir, PVC piping, gravel and bottle-cap media, and lettuce (*Lactuca sativa*) seedlings. Nile tilapia (*Oreochromis niloticus*) fingerlings were stocked at 20 kg/m³ and fed daily. Water quality (NH_4^+, NO_3^-, pH, DO) was monitored over 30 days using standardized methods (Danner *et al*. 2019).

Table 1. Locally Assembled Aquaponics System Cost Estimate (UGX)

Item	Qty	Unit Cost	Total Cost
Plastic fish tank (1 000 L)	1	300,000	300,000
Drum reservoir (200 L)	1	30,000	30,000
PVC pipes & fittings	Assorted	—	100,000
Gravel/bottle-cap media	1 kg	2,000	2,000
Lettuce seedlings	10	1,000	10,000
Total			**444 000**

Bottle-cap media may be replaced with recycled sponges or bottle caps

Results: Biofilter media setups reduced NH_4^+ from 0.8 ± 0.1 to 0.1 ± 0.02 mg/L within 7 days, while NO_3^- increased from 2.5 ± 0.3 to 10.2 ± 1.1 mg/L. Lettuce biomass increased by 98% (wet weight), and fish survival exceeded 90%. Cost benefit analysis showed payback in six months at existing market

Market surveys in Kampala showed that fish could be bought at UgX 12,000–15,000/kg and lettuce at UgX 800–1,200/head. Local innovations and community training have fostered adoption among youth and women especially in urban areas. With policy support and capacity building, aquaponics can enhance Uganda's urban food security and livelihoods.

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PREVALENCE AND MEAN INTENSITY OF *Clinostomum* species INFESTING FARMED *Oreochromis* species IN MPIGI AND WAKISO DISTRICTS, CENTRAL UGANDA

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Nile tilapia is crucial for food security and income in Uganda. However, the expanding aquaculture sector faces challenges, notably diseases and parasites including the zoonotic trematode *Clinostomum*, which threaten tilapia farming. Data on its prevalence in Uganda remains limited. This cross-sectional study evaluated the prevalence and mean intensity of *Clinostomum* species in farmed tilapia in Mpigi and Wakiso districts in the Lake Victoria Crescent aquaculture zone.

Data was collected between December 2023 and January 2024 from 30 farms (23 ponds,7 cages) using semi-structured questionnaires and fish sampling. A total of 286 tilapia were harvested using seine and scoop nets: 216 from ponds and 70 from cages; 259 were *Oreochromis niloticus* and 27 *O. leucostictus*; 224 were male and 62 females; 134 fish were from Mpigi and 152 from Wakiso district. Necropsy examination was conducted on the sampled fish at the parasitology laboratory of College of Veterinary medicine, Makerere University. *Clinostomum* larvae were isolated and microscopically identified using morphological keys.

Among 286 tilapia, 86 *Clinostomum* larvae (yellow grubs) were isolated from 9 pond fish in 4 farms in Mpigi district, resulting in a 3.2% overall prevalence. Two species were identified: *C. cutaneum* (84 larvae, 2.8% prevalence) in skin tissue and *C. complanatum* (2 larvae, 0.4% prevalence) in the gill cavity of one fish (Figure 1). Prevalence differed significantly between tilapia species and districts ($p<0.05$). The overall mean intensity was 9.5 larvae, with *C. cutaneum* at 9.3 and *C. complanatum* at 2.0 (Figure 2). The mean intensity differed significantly between tilapia species ($p<0.005$). Therefore, implementation of control strategies is recommended, along with further research on the epidemiology and molecular confirmation of these species.

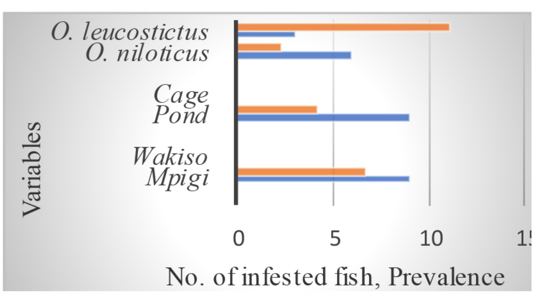

Figure 1: Prevalence of *Clinostomum* spp. infesting farmed tilapia in Mpigi and Wakiso districts.

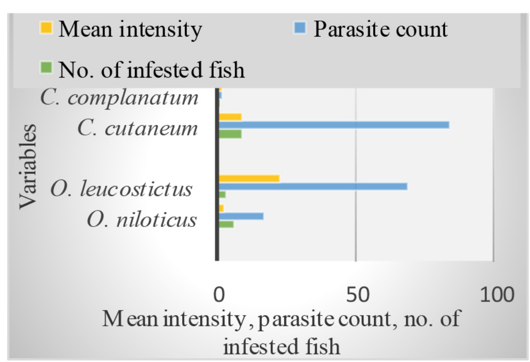

Figure 2: Mean intensity of Clinostomum spp. infesting farmed tilapia in Mpigi district.

CHARACTERIZATION OF *Edwarsiella tarda* AND SELECTED BACTERIOPHAGES FOR DEVELOPMENT OF AN ALTERNATIVE ANTIMICROBIAL AGENT FOR USE ON FISH FARMS IN UGANDA

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The requirement for minimized use of antibiotics and the ban on antibiotic-supplemented feeds calls for alternative disease control approaches, like the use of bacteriophages (viruses of bacteria). Currently, there are no locally characterized bacteriophages against *Edwardsiella tarda* as a cheap alternative for the management of "Edwardsiellosis" on fish farms in Uganda. This study characterised *in vitro*-lytic activity and genotypic properties of selected bacteriophages against *E. tarda*.

Edwardsiella tarda-specific phages from the gut contents of market fresh tilapia fish were isolated and purified by the double agar overlay plaque technique. Spot assay was used to determine *in vitro*-lytic activity, pH and temperature stability; as well as one-step growth curve and antibiofilm activity. Oxford Nanopore Technology and Illumina technology were used to sequence the genomes of the host bacteria and one phage strain, respectively. A *de novo* genome assembly was done using various bioinformatic tools. Presence of resistance and virulence genes was determined using bact_hybv4 and online public bioinformatics websites. Phylogenetic tree for both phage and host genomes were constructed using Mega11 and edited using FigTreeV1.4.4 software.

Results: Three lytic phages against *E. tarda*, viz USF_EDP_P1, USF_EDP_P2, and USF_EDP_W10 were identified. Plaque sizes ranged from 1-2mm; efficiency of plating (EOP) of 1, Multiplicity of Infection 0.4 - 0.8. Only one phage USF_EDP_W10 demonstrated high host range with a burst size of 400 PFU/infected bacterial cell and, burst time of 10 minutes (Fig 1A). Highest phage stability was recorded between -20˚C and 30˚C and pH of 7-7.5 (Fig 1B and C). The phage exhibited antibiofilm activity. Predicted genes of phage genome included holin, endolysin, and spanin but not AMR and virulence genes. Phylogenetic tree structure clustered the phage USF_EDP_W10 together with the genus *Moonvirus*.

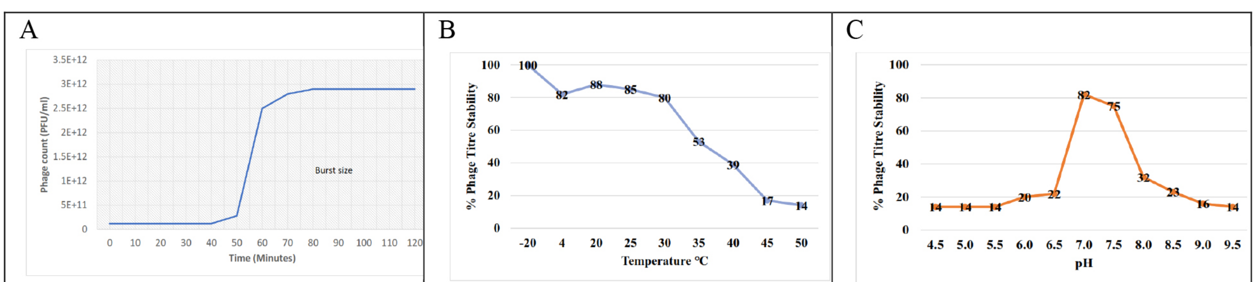

Fig1. One growth curve (A), Temperature (B) and pH (C) phage stability after 60 min exposure

Genotypic characterization and *in vitro* lytic activity of USF_EDP_W10 revealed it as a virulent phage and its potential application for edwardsiellosis management in aquaculture.

CHARACTERIZATION OF *Edwarsiella tarda* AND SELECTED BACTERIOPHAGES FOR DEVELOPMENT OF AN ALTERNATIVE ANTIMICROBIAL AGENT FOR USE ON FISH FARMS IN UGANDA

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The requirement for minimized use of antibiotics and the ban on antibiotic-supplemented feeds calls for alternative disease control approaches, like the use of bacteriophages (viruses of bacteria). Currently, there are no locally characterized bacteriophages against *Edwardsiella tarda* as a cheap alternative for the management of “Edwardsiellosis” on fish farms in Uganda. This study characterised *in vitro*-lytic activity and genotypic properties of selected bacteriophages against *E. tarda*.

Edwardsiella tarda-specific phages from the gut contents of market fresh tilapia fish were isolated and purified by the double agar overlay plaque technique. Spot assay was used to determine *in vitro*-lytic activity, pH and temperature stability; as well as one-step growth curve and antibiofilm activity. Oxford Nanopore Technology and Illumina technology were used to sequence the genomes of the host bacteria and one phage strain, respectively. A *de novo* genome assembly was done using various bioinformatic tools. Presence of resistance and virulence genes was determined using bact_hybv4 and online public bioinformatics websites. Phylogenetic tree for both phage and host genomes were constructed using Mega11 and edited using FigTreeV1.4.4 software.

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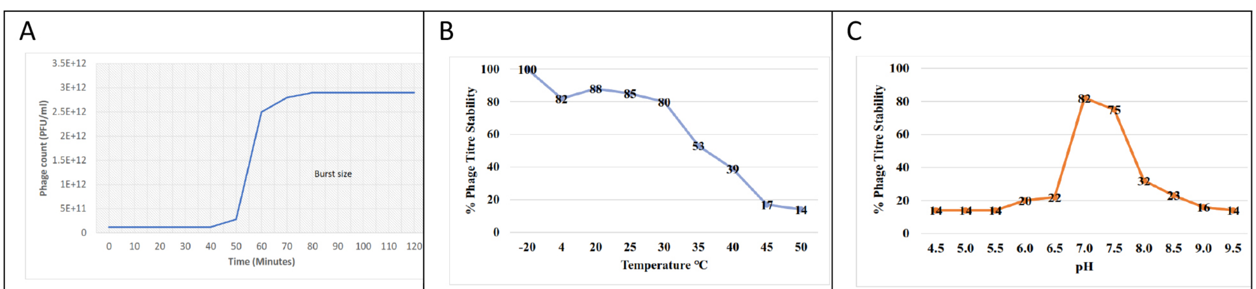

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COMPETENCE TO IMPACT: EDUCATION AND RESEARCH IN AQUACULTURE AS A GHENT UNIVERSITY GRADUATE

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As a VLIR-UOS scholarship (ICP) recipient and alumnus of Ghent University (MSc Aquaculture, Faculty of Bioscience Engineering), I gained practical and research skills tailored to African and Asian aquaculture systems, encompassing both marine and freshwater species. The course focused on a deep exploration of aquaculture principles and applications, as well as value chain development. More specifically, it emphasized the ability to critically evaluate scientific literature, design context-relevant research, and apply findings effectively. My MSc studies were conducted at the peak of the COVID-19 pandemic, which required a shift to online learning, and with the strong support of faculty, I was able to implement my research design and study at the Artemia Reference Lab. This experience built resilience, sharpened my ability to work independently and innovatively, skills that now propel my problem-solving capabilities in the fisheries and aquaculture sector.

For instance, as a thematic leader under the PESCA Project, I coordinated a unique collaboration between researchers from NaFIRRI- Kajjansi, academia from the zoology department in Makerere University, and the government (Fisheries Directorate) to develop an aquaculture compendium for short-course training. Yet, currently, for my doctoral studies, focused on the use of natural reproductive enhancers (*Mondia whitei*) in African cichlids (*Oreochromis shiranus*) as an aphrodisiac, I have been able to set up a well-structured experiment despite the hindrances that accompany developing countries with limited access to equipment and modern technology.

My journey reflects how flexible, innovation-driven education can empower graduates to lead, adapt, and drive sustainable change in African aquaculture. To advance African aquaculture further, education should enhance conventional aquaculture practices with innovative genetic studies and climate-smart innovations. There is also a need to explore other capable aquaculture candidates beyond *Oreochromis niloticus* and *Clarias gariepinus*, as well as nano and probiotic feeds. Courses that emphasize financial management (bookkeeping, rate of return, break-even analysis), value addition beyond frying and smoking, and marketing strategies would enhance Africa's aquaculture.

GROWTH AND REPRODUCTIVE PERFORMANCE OF *Oreochromis shiranus* (BOULENGER 1896) BROODSTOCK FED ON DIVERSE DIETS UNDER INTERMITTENT HARVESTING REGIME

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The study was conducted to assess the growth and reproductive performance of *O. shiranus* fed on unfermented maize bran (UMB) fermented maize bran (FMB) and commercial floating pellets (CFP) under intermittent harvesting (IM) regime. The fish were reared for a period of 126 days, while daily intermittent harvesting of juveniles started after 54 days of stocking. Harvesting was conducted using two meshed wire fish traps in every pond, set out an hour, before the fish were fed. In experiment I, the final weight of broodstock was not significantly different ($p= 0.811$) between SB and IM. Furthermore, number of Juveniles produced by broodstock under Single batch harvest (SB) did not differ significantly ($p =0.308$) from intermittent harvest (IM). In experiment II, the broodstock fed on the CFP recorded a higher final weight of 148.24±16.04g, followed by broodstock fed on UMB (93.46±9.95g) and 89.16±7.86 g from broodstock fed on FMB. However, the final weight on UMB and FMB diets did not differ significantly ($p= 0.964$). The highest number of Juveniles, at ≈ 8572±495 and a total Juveniles yield of 4162.74±6.94 kg/ha/yr of mean weight of 8.75g were harvested from broodstock fed on CFP diet and ≈ 2157±183 Juveniles and a total Juveniles yield of 848.77±3.56 kgs/ha/yr of mean weight of 4.75g harvested from broodstock fed on UMB. Lowest number of Juveniles of 1717±123 and a total yield of 534.46±1.59 kg/ha/yr of mean weight of 3.67 g was reported from broodstock fed on FMB. This suggests that the use of CFP under IM would produce better results as evidenced by the highest final weight and high number of Juveniles above all treatments and IM is not better off than SB, as the final growth of broodstock and number of juveniles was not significant different among treatments.

GENOMIC CHARACTERIZATION OF *Aeromonas hydrophila* F7 AND ITS LYTIC BACTERIOPHAGE

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Aeromonas hydrophila is a significant fish pathogen with reported antibiotic resistance worldwide. The use of antibiotics as a disease management strategy is associated with the emergence of antimicrobial resistance, which requires alternative disease management strategies. Bacteriophages, the viruses that specifically kill bacteria, are increasingly exploited. However, bacteriophage applications in Ugandan aquaculture remain underexplored due to the limited proper characterization. Thus, we aimed to genetically characterize *A. hydrophila* (F7) and its lytic bacteriophage.

Genomic DNA from both the *A. hydrophila* (F7) bacterium and its phage, Aero_phi 01, were extracted and sequenced utilizing the Illumina platform. Genome analysis involved pre-processing, assembly, annotation, and comparison with other known genomes in the gene databases. Additionally, a proteomic phylogenetic tree was constructed to further elucidate the genetic relationships.

The genome of *A. hydrophila* consisted of over 4 Megabases (MB), with a total of 3992 annotated features. Eight CRISPR arrays, a prophage partial_01 sequence and four specific antibiotic resistance genes (though not exhibited phenotypically) were detected. The phage genome had approximately 54 KB and a total of 77 coding sequences, belonged to the *Melnykvirinae* subfamily within the *Autographiviridae* family of Caudoviricetes, a group of double-stranded DNA viruses and was not identical to a prophage detected on the host genome.

The characterisation of both F7 and the phage provided crucial insights into their suitability for phage applications in disease management and mitigation of antibiotic resistance in fish farming, contributing to global food security and public health.

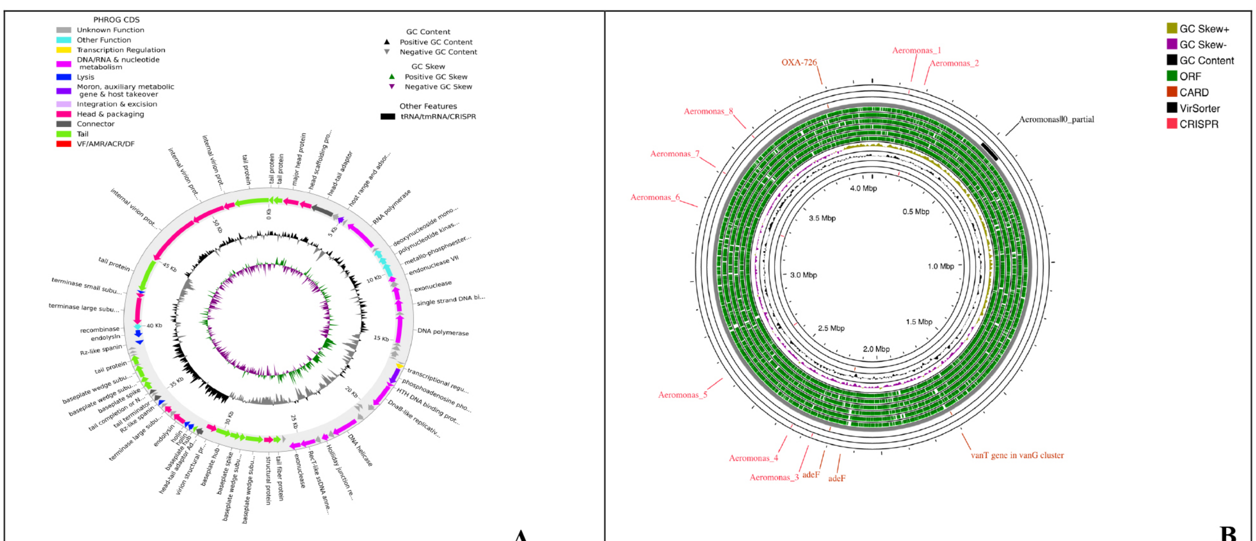

Fig 1: Genomic characteristics of (**A**) AeroPhi 1 phage and its *Aeromonas hydrophila* F7 host **(B)**

FEED QUALITY ATTRIBUTES OF PROCESSED POULTRY BY-PRODUCTS

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Uganda's growing aquaculture industry requires innovative and sustainable feed sources to meet its ambitious production target of 1,000,000 metric tons of fish annually. This study explored the potential of poultry by-products (PBP), such as offal, day-old cocks, and unhatched eggs, as cost-effective protein ingredients in fish feed formulation. The study aimed to optimize the local NARO PAH-SAFE smoking kiln technology for processed PBP, characterize the nutritional and physical properties of the resulting meals, and assess their shelf-life and microbiological quality.

At Ugachick poultry breeders, PBP were received sorted, weighed, steam cooked, dripped, dried, cooled and milled.

Findings indicated significant variability in yield, physical and nutritional properties among the different by-products. Unhatched eggs had the highest cooking yield, Offal with the highest drying yield and DOC drying required more drying energy almost 3.5 folds higher than EGG and Offal. Milling yield; Offal>DOC>EGG, although the drying cost was highest for DOC, PBP processing was cheaper than the cost of dried conventional protein sources such as silver cyprinid by a factor of 2.2.

Colour is important for attracting fish to feed and was consistent over storage time, light brown for DOC, brown for EGG and dark brown for OFF. Particle size ranged between 1mm to 2mm particle size with the highest percentage obtained from EGG and lowest in DOC.

Day-old cocks (DOC) exhibited the highest crude protein content (77.4%), making them a superior protein source, while unhatched eggs and offal demonstrated stability in fat content. Protein composition for all PBP was comparable to silver cyprinid and generally higher compared to other protein sources. DOC was rich in methionine 3.8 times higher than silver cyprinid, high tryptophan across PBP was observed that are essential for tissue growth and muscle development, strong immunity and stress management in fish. High Omega 3 and 6 was registered especially in offal.

Although nutrient composition varied over storage time with increase in percentage crude protein and crude fat to almost constant up to 2 months, PBP were microbiogically safe free from *salmonella* and *Escherichia coli.* ensuring the safety and stability of these by-products. Hence, critical in reducing the feed cost for Uganda's expanding aquaculture sector and promoting resource sustainability.

ASSESSMENT OF FACTORS LIMITING FARMER'S ADOPTION OF METHODS FOR PREVENTION, CONTROL AND TREATMENT OF FISH HEALTH CHALLENGES ON THEIR FARMS IN WAKISO DISTRICT

By Alice Namata *David Kahwa

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Aquaculture is among the fastest growing industry contributing 16% of the animal source of protein consumed by humans globally. In Uganda major farmed species are Nile tilapia and African catfish. Efforts by the government to improve the industry have largely been geared towards financial investments, quality feed and seed neglecting fish health as one of the constraints to production. This study aimed at finding out the factors limiting farmers from adopting the various fish health management practices recommended. A total of twenty four fish farms in Wakiso District were assessed using a cross sectional study design. A highly significant number (87.5%) (*Chi-square value* $(x^2) = 21$, $n=24$, $p=0.001$) of farmers had a fish health management plan in place, all of them fed their fish, only 37.5% had a biosecurity protocol in place while 62.5% didn't have. Treatments, carcass disposal, cleaning of equipment and isolation were done to some extent by those who had experienced a fish health challenge on their farms. None of the farms assessed utilised vaccinations and plant extract use for management of fish diseases. This was largely due lack of knowledge about these strategies. Other farmers thought some of the fish health management practices were not relevant/necessary as they had never experienced any fish health challenge on their farms. It was observed that disease occurrence, knowledge and relevance were some of the influencing factors for farmers to adopt and implement fish health management practices. It is therefore important to disseminate important knowledge from research to the beneficiaries so as to build a sustainable industry.

ACTIVITIES AND BENEFITS OF A NEW WAVMA STUDENT CHAPTER AT MAKERERE UNIVERSITY, UGANDA

PROMOTING THE DISCIPLINE OF AQUATIC VETERINARY MEDICINE AMONG EMERGING VETERINARIANS

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The minimal involvement of veterinarians with aquatics is a concern for the Uganda's rapidly expanding commercial aquaculture industry. Fish farmers are concerned about disease insurgence and there are growing issues over antimicrobial resistance in aquaculture, welfare of farmed fish, and aquaculture sector's compliance to One Health. The trends in Uganda's aquaculture industry is currently demanding for comprehensive aquatic veterinary services. However, there are limited training opportunities offered through the veterinary school curriculum. The Makerere University World Aquatic Veterinary Medical Association Student Chapter (MAK-WAVMA-SC) was established in 2022. Since its establishment, MAK-WAVMA-SC members have been active in boosting opportunities to expose veterinary students to aquatic veterinary medicine, under the supervision of an academic advisor. The WAVMA community has proven to be an excellent resource for nurturing students interested in aquatic veterinary medicine practice. The WebCEPD webinar series introduced MAK-WAVMA-SC members to new topics and advanced technologies in fish health and aquaculture management practices. The MAK-WAVMA-SC also offers an opportunity for local veterinary students interested in aquatic veterinary medicine to interact with other students from other countries, allowing to identify local strengths and weakness. Membership to MAK-WAVMA-SC has been a real eye opener that will improve our ability to practice aquatic veterinary medicine. The John Pitts Award offered through WAVMA to support Student Chapters is an additional WAVMA-SC do benefit from to undertake Student Chapter projects and related educational activities.

CASCADING AQUACULTURE RESEARCH IN UGANDA: A REVIEW

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Aquaculture has been practiced in Uganda for more than 70 years. Uganda's aquaculture annual production however contributes only 5.5% to Africa's and 0.1% to global production respectively. To this effect, several research interventions have been advanced to with a purpose of generating technologies to trigger increase in aquaculture production. This review explores research technologies, innovations and management practices as interventions purposed to achieve sustainable aquaculture production in Uganda.

A comprehensive literature search was conducted on published literature, grey literature, and online information sources using search terms such as "aquaculture" "nutrition", "Uganda", "research", "studies", "aquafeed", "fish diseases", "production systems", "fish genetics", "aquaculture policy", "aquaculture information", "social economics", "new species", "genetics", "feed formulation", "ingredients", "fish hatchery" and "feed management practices", with focus placed on information published in English.

The search generated 140 research articles, 99% of which were published between 2001 and 2025. Of these, 21% addressed aquaculture nutrition; 11% talked to aquaculture genetics, fish propagation and hatchery management; 14% focused on aquatic animal health; 14% featured aquaculture production systems and management; 16% addressed high value aquaculture candidate species; 21% assessed aquaculture social economic aspects; 1% addressed aquaculture policy; and 1% looked at aquaculture information management. The articles present with variances in scientific quality and increased in frequency as the 2000s advanced, which directly related to the increase in aquaculture production reported after the year 2000. While significant breakthroughs were reported, the review revealed deficiencies in research tools used in collection, assessment and analysis of data compared to what is observed elsewhere in advanced aquaculture research settings. This could explain why Uganda's aquaculture production is still lagging behind.

There is creates opportunity for advanced research undertakings in the different aquaculture research areas, towards generation of advanced technologies for sustainable aquaculture production.

SUSTAINABLE PROTEIN SNACKS FROM UNDERUTILIZED NUTRIENT SOURCES

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In Uganda, around 60% of fish farmers exit the sector annually due to high feed costs, which account for over 65% of production expenses—an unsustainable burden for most smallholders. Combined with poor management, this has led to widespread stunting in pond-raised fish and affects 20% of cage-cultured fish. Stunted fish, though rich in protein, omega-3s, and micronutrients, they are often discarded or sold cheaply, limiting their value. This underutilization persists amid widespread malnutrition, especially among pregnant women and children, whose diets lack adequate protein and essential nutrients.

To address this, the study developed nutrient-dense, sustainable protein bars using underutilized local ingredients: house crickets (*Acheta domesticus*), stunted Nile tilapia (*Oreochromis niloticus*), fermented cassava (*Manihot esculenta*), sprouted Longe 11H maize (*Zea mays*), and orange-fleshed sweet potatoes (OFSP). Nutricalc software guided formulations, with ingredient proportions reaching up to 39.2% tilapia, 22.6% cricket powder, 38.4% OFSP, 34.5% sprouted maize, and 38.4% fermented cassava. The blends were spiced, molded, and baked at 175°C for 10 minutes.

Sample 2 (38.4% tilapia, 23.6% cassava, 27% honey, 10% dates, 2% spices) showed high nutritional value (Table 1) and good sensory scores: appearance (7.2), color (7.3), aroma (6.5), taste (5.8), texture (6.3), and overall acceptability (6.0). The bars supported children's nutrient intake and, to prevent excess protein consumption, should be paired with carbohydrate-rich foods (Table 2).

FISH HEALTH CHALLENGES AND THEIR MANAGEMENT IN FISH HATCHERIES OF UGANDA

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With increasing aquaculture intensification, emergence of fish health challenges is expected, hence, a country-wide baseline survey was conducted to explore the fish health challenges in fish hatcheries. This was done using a face-to-face questionnaire where 48% of the 56 visited hatcheries had experienced fish disease incidences, with the African catfish being the most affected species (81.5%). Disease signs and symptoms were mainly observed during the larva (51.9%), the fry (66.7%), fingerling (55.6%), and larva (51.9%) stage. Among 27 hatcheries, the most common disease signs and symptoms observed were cotton-wool growth (20), red spots on skin and fins (12), fish swimming upside down (12), and tail and fin rot (11). The analysis revealed that both the experience level of the farmer and the type of hatchery facility exhibited significant associations with disease signs and symptoms in hatcheries, with p-values of 0.0134 and 0.008, respectively. Most (65%) hatcheries monitored water quality. The majority (66.1%) of the hatcheries released their hatchery effluents directly into the natural waterways without prior treatment. These findings provide a benchmark to improve management strategies for increased survival rates and production in hatcheries.

EMERGING PATHOGENS ISOLATED FROM TILAPIA RAISED IN THE LAKE VICTORIA REGION, UGANDA: *Aeromonas sp, Edwardsiella sp* AND *Francisella sp*

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Tilapia production from aquaculture is growing fast in Uganda to meet the increasing demand for fish. Farm yields and profits are increasingly reduced by periodic disease outbreaks in land and water-based systems. High mortalities experienced within hatcheries and cage systems with infected fish presenting signs of lethargy, exophthalmia, granulomatous spleen, fin rot, ulcerations and haemorrhages. Histopathological reports showed gill hyperplasia with epitheliocystis, and granulomatous head-kidney, spleen, liver with melanomacrophages. However, asymptomatic fish samples showed recovery stages of populations as exhibited in granulomas spleen and kidney. Molecular identification revealed unique strains of *Aeromonas veronii, A. hydrophila of Edwarsiella ictaluri, E. anguillarum, Francisella philomiragia*, *F. noatunensis* and *F. tularensis* from infected farmed tilapia in Uganda. These were resistant to Ampicilin and Amoxicillin, erythromycin and sulphamethoxazole trimethoprim, respectively. Identification of co-occurrence of these emerging pathogens presents strategies to reduce further economic losses in the tilapia industry.

A SCALABLE TRAINING MODEL USING DIDACTICS AND ANDRAGOGY FOR SUSTAINABLE AQUACULTURE DEVELOPMENT IN INDIA

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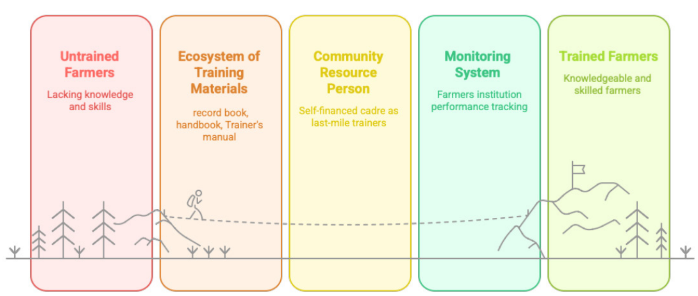
The Indian fisheries sector has experienced an average annual growth rate of 8.61% over the past eight years, underscoring the potential of aquaculture as a driver of employment and livelihood generation. Despite this growth, facilitating effective large-scale training in freshwater aquaculture remains a significant challenge, especially for small-scale farmers in rural settings.

To address this gap, the Indo-German SAFAL project, funded by BMZ and implemented by GIZ in partnership with India's Ministry of Fisheries, conceptualized a scalable training model integrating didactic principles and andragogical approaches. The model was co-created through participatory research, stakeholder consultations, and design-thinking workshops involving trainers, learners, curriculum designers, practitioners and scholars. The resulting ecosystem comprises (i) context-specific training content tailored to learner profiles, (ii) a standardized trainer framework using adult learning techniques, and (iii) lean information, education, and communication (IEC) materials for field-level application.

The model was deployed across selected districts in Odisha and Assam, reaching over 6,000 small-scale farmers through 17 Farmer Producer Organizations (FPOs) and 100 Producer Groups (PGs). Preliminary assessments indicate improved content retention, increased adoption of best aquaculture practices, and enhanced learner engagement.

The integrated training model demonstrates that combining didactics and andragogy within a structured ecosystem of knowledge resources and field-ready materials significantly improves training efficacy. However, contextual limitations need to be considered. This approach could be replicable across similar geographies and holds promise for scaling sustainable aquaculture practices.

Figure 1. A Scalable Effective Training Model



Escherichia coli ANTIMICROBIAL SUSCEPTIBILITY PROFILE AND GUT MICROBIOME DYNAMICS IN FARMED NILE CROCODILE HATCHLINGS WITH ENTERITIS

Kunda Ndashe[1], Jaelle Rowland[2], Kohei Ogasawara[3], Kanami Watanabe[3], Mark Flint[4], Katendi Changula[1], Sibusiso Khumalo[1], Bernard Mudenda Hang'ombe[1,5], Innocent Billy Ng'ombwa[6], Shouta M. M. Nakayama[3], Mayumi Ishizuka[3], Chris M. Foggin[7]

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4. Flint Welfcare, Ohio, USA
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7. Victoria Falls Wildlife Trust, Victoria Falls, Zimbabwe

Enteritis remains a significant cause of mortality in farmed Nile crocodile (*Crocodylus niloticus*) hatchlings, with *Escherichia coli* frequently implicated in disease outbreaks. This study aimed to assess the antimicrobial susceptibility profiles of *E. coli* isolates from affected hatchlings and characterize the gut microbiome dynamics during enteritis episodes in intensive farming systems. A longitudinal investigation (2018–2024) was conducted across four Zambian crocodile farms, involving bacterial isolation and antibiotic susceptibility testing of E. coli from 62 confirmed outbreaks. In 2024, 16S rRNA gene sequencing was performed on gastrointestinal tract samples to analyze microbial community composition along the stomach, anterior, mid, and posterior intestines.

Results revealed a marked increase in antimicrobial resistance among *E. coli* isolates over time, with complete resistance to amoxicillin–clavulanic acid, tetracyclines, and trimethoprim–sulfamethoxazole observed by 2024. Enrofloxacin remained the most effective antibiotic, with approximately 70% susceptibility retained. Gut microbiome profiling showed dominance of Proteobacteria, particularly Enterobacteriaceae, across all intestinal segments, indicative of microbial dysbiosis. Diversity increased distally along the gut, with *Fusobacteriota*, *Clostridiota*, and *Bacteroidota* becoming more prominent in the posterior intestine, though *Enterobacteriaceae* persisted at high levels.

The study highlights a concerning trend of multidrug-resistant *E. coli* in crocodile hatchlings, likely driven by antibiotic misuse, and underscores the role of gut dysbiosis in enteric disease pathogenesis. These findings emphasize the need for integrated health management strategies that promote prudent antibiotic use and explore microbiome-restoring interventions such as probiotics. Improved biosecurity, targeted treatment guided by antibiograms, and support for healthy gut flora may enhance hatchling resilience and reduce outbreak frequency in commercial crocodile farming.

THE WORLD AQUATIC VETERINARY MEDICAL ASSOCIATION

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The World Aquatic Veterinary Association (WAVMA), is a not-for-profit professional organization established to support aquatic veterinarians, aquatic veterinary nurses and veterinary students practice and support the aquatic animal sectors and careers of aquatic animals enhance aquatic animal health and welfare, public health, and seafood safety. WAVMA is affiliated with the World Veterinary Association. As an organization, WAVMA achieves this by developing programs to support and sustain its members and other aquatic veterinary medicine practitioners of many disciplines and backgrounds serve their sectors competently; provides a platform to strengthen professional interactions among aquatic medical practitioners and other organizations around the world; advocate for, develops guidance on, and promotes the advancement of the science, ethics and professional aspects of aquatic animal medicine within the veterinary profession and a wider audience; and promotes the discipline and supports the practice of aquatic veterinary medicine in all countries.

ACCLIMATIZATION OF TILAPIA *Oreochromis andersonii* TO SEA WATER UNDER AQUACULTURE CONDITIONS: MITIGATING THE IMPACT OF CLIMATE CHANGE IN NAMIBIA

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Namibia is an arid country with limited freshwater but blessed with a coastline that runs 1500Km north to south of the west boarder line. Where freshwater is available, competing activities like irrigation and livestock uses takes priority. This contrast provides a unique opportunity for Namibia's aquaculture development. Equally, limited growth of tilapia aquaculture in Namibia has been pointing to lack of fresh water among other challenges. Acclimatization of tilapia to seawater has been happening at SANUMARC. This initiative aims to provide an alternative tilapia strain that can be grown in seawater and saline water bodies. The laboratory aspects have been on going such that the strain is now in its 5th generation. The availability of this local tilapia specie's saline strain represents options to unlock Namibia's tilapia aquaculture growth.

STATUS OF CORAL HEALTH AND DISEASE MANAGEMENT IN THE WESTERN INDIAN OCEAN: KENYAN CONTEXT

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Coral reef ecosystems which cover less than 0.5% of the seafloor, support at least 25% of marine species, provide coastal protection, wellbeing, food and economic security to millions of people globally through tourism and recreation. These are species diverse and productive ecosystems where the Western Indian Ocean coral reefs cover approximately 5% of the global coverage. Additionally, global estimates indicate that coral reefs contribute US$2.7 trillion per year in ecosystem service value, including US$36 billion in coral reef tourism. As a result of increased reef degradation, restoration efforts are widely applied on coral reefs through coral aquaculture to minimize the increase in threats to coral reefs and to meet the growing demand for their use in marine ornamental trade and pharmaceutical industry globally. Coral aquaculture offers an alternative to wild harvest and it has a considerable promise for restoring reefs and preserving biodiversity. In situ coral aquaculture involves cultivating corals within their natural habitats to enhance coral cover and health conditions while ex situ coral aquaculture involves controlled coral cultivation in aquarium or tanks to optimize coral production. Successful commercial coral aquaculture relies on qualitative and quantitative parameters such as shape, coloration and natural product content, as well as growth and volumetric productivity respectively. However, out-planted coral survival in restoration zones varies significantly where coral mortality can be a significant limitation to the success of restoration efforts. Further, despite its promising potential, coral aquaculture is challenged with sediment deposition, various types of emerging diseases and compromised health. The underlying causes of mortality, the potential for disease, and the role of infectivity associated with mortality events have not yet been widely determined. Studies have indicated coral mortality, coral disease prevalence and coral bleaching prevalence as indicators of coral condition. This far coral disease outbreaks are increasing in impact and frequency worldwide attributable to coastal water pollution and climate change. In the WIO region and East Africa, Black band disease (BBD), Fungal syndrome, white syndrome (WS), pink line syndrome (PLS), growth anomalies (GA), skeleton eroding band (SEB), Porites white patch syndrome (PWPS) and Bacterial Bleaching have been reported affecting *Astreopora, Montipora, Echinopora, Acropora, Goniopora, Platygyra, massive Porites, Pocillopra, Goniastrea, Hydnophora, Cyphastrea and Oculina pategonica.* While diseases affecting corals have increased there are few individuals throughout the world trained to diagnose diseases on coral reefs. There are limited studies on status of coral health and diseases in the Western Indian Ocean and by extension to Kenya. Thus understanding the underlying microbial, biological, and environmental drivers of mortality and disease in restoration programs provides a means by which to develop optimal strategies to support coral survival. Therefore, there is need for capacity building in coral identification, coral disease identification and management, enhanced regulatory frameworks on coral gardening investment and provision of adequate technical support.

CIRCULAR ECONOMY FOR WATER AND NUTRIENTS: NUTRIENT CREDITS FROM RECIRCULATING AQUACULTURE SYSTEM (RAS) EFFLUENT OFFSET SYNTHETIC FERTILIZER AND ENHANCE LETTUCE *Lactuca sativa* PERFORMANCE

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Recirculating aquaculture systems (RAS) are expected to play an important role in aquaculture's continued growth. RAS largely conserves water, but substantial volumes of water still leave the system while backwashing mechanical filters and flushing accumulated nitrogenous wastes. While aquaponics is expensive and has limited capacity to absorb such volumes of effluent, field crops can provide the land base to absorb this nutrient-rich water that might otherwise be wasted. Using lettuce (*Lactuca sativa*) to compare tilapia (*Oreochromis niloticus*) RAS effluent against synthetic fertilizer and synthetically amended RAS effluent, this study centers on the hypothesis that integrated aquaculture and agriculture minimize waste while maximizing productivity.

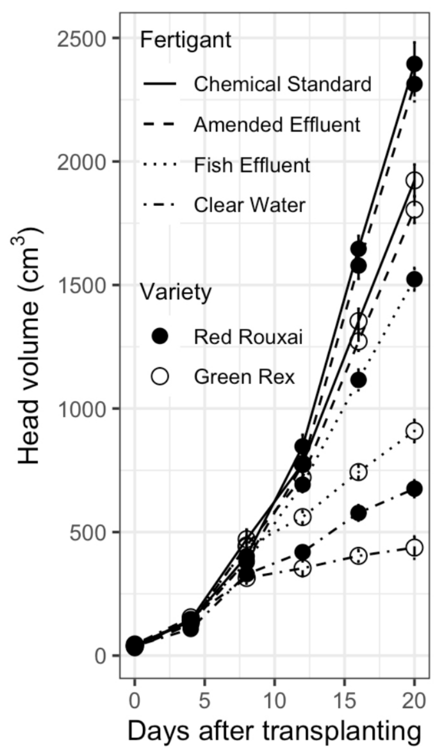
A 21-day growth trial was set up with 2 varieties of lettuce (Rouxai; Rex), and 4 levels of fertigation: water control, RAS effluent, soluble 21-5-20 fertilizer control at 100ppm NO_3-N, and RAS effluent amended with a lower dose of 21-5-20 fertilizer to reach a combined 100ppm NO_3-N. The plants were transplanted 15 days from seeding, with 96 plants in total (n = 12). An earlier analysis of the RAS effluent composition is reported in Table 1. Lettuce head volume was calculated throughout the growth period (Figure 1). Fresh weight, leaf area, chlorophyll, and tissue composition were evaluated at the trial's termination.

The goal of the trial was to determine the fertilizer value of the RAS effluent alone and the extent to which RAS effluent nutrient credits can offset synthetic fertilizer in a complementary system. At 20 days from transplanting, amended effluent was not different from the synthetic fertilizer control for both varieties (p>0.1). Plants receiving unamended fish effluent were on average twice the size of those receiving only water (p<0.001) but still only half as large as those receiving amended effluent (p<0.001). In all, nutrient credits from RAS effluent are shown to offer substantial fertilizer savings without compromising plant productivity when used in combination with synthetic fertilizer.

TABLE 1. Preliminary RAS effluent composition (N=8).

Parameter	Concentration (ppm; mean ± sd)
$CaCO_3$	2.35 ± 4.35
NO_3-N	64.04 ± 1.66
NH_4-N	4.60 ± 0.54
P	12.00 ± 0.34
P_2O_5	27.50 ± 0.79
K	13.26 ± 0.30
K_2O	15.97 ± 0.36
Ca	84.37 ± 0.82
Mg	14.81 ± 0.12
S	13.16 ± 0.22
SO_4	39.48 ± 0.65

FIGURE 1. Plant growth by fertigant and variety. Error bars denote mean ± 1SE.



ADVANCING *ARTEMIA* FARMING IN KENYA: OPPORTUNITIES, CHALLENGES AND FUTURE PLANS

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Artemia farming in Kenya was introduced in the early 1980s through the Kenya-Belgium Project to assess its feasibility in salt ponds. Over the years, three major projects have been implemented: the initial feasibility study in the 1980s, a 2010 initiative to improve coastal community livelihoods, and a 2020 collaborative project to enhance production and expand *Artemia* farming to Tanzania. Kenya's *Artemia* farming is closely linked to commercial and artisanal saltworks along the coast, with production primarily targeting cysts and biomass for aquaculture hatcheries. Despite efforts to promote local production, the country remains largely dependent on imported *Artemia* cysts, which are crucial for hatcheries producing marine fish, shrimp, and ornamental species. However, with the World Bank through the Kenya Marine Fisheries and Socio-Economic Development (KEMFSED) project supporting four marine hatcheries in the country, the demand for *Artemia* is expected to rise, hence the need to enhance the local production. Given its extensive saline ponds, favourable climatic conditions, and growing aquaculture sector, Kenya has significant potential for *Artemia* farming. While *Artemia* farming is already integrated with salt production, its full potential remains underutilized due to challenges such as low production efficiency, rudimentary cyst harvesting methods, and genetic dilution of introduced strains. Recent advancements, including investments in *Artemia* cyst processing and research on improved farming practices, aim to strengthen local production. Future opportunities lie in enhancing *Artemia*-salt farm integration, expanding market linkages, and improving policy support to reduce reliance on imports. Strengthening local supply chains and modernizing harvesting techniques will be crucial in positioning Kenya as a key *Artemia* producer within East Africa, supporting the growth of aquaculture in the region.

HEAVY METAL ACCUMULATION IN THE STRAIGHTFIN BARB (*Enteromius paludinosus*) FROM RIVER MALEWA, NAIVASHA, KENYA: IMPLICATIONS FOR AQUACULTURE SUSTAINABILITY AND FOOD SAFETY

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Aquaculture in East Africa is expanding rapidly, providing a vital source of nutrition and economic livelihood. However, environmental contamination, particularly heavy metal pollution, poses a significant threat to fish health, aquaculture productivity, and consumer safety. Mercury (Hg), arsenic (As), chromium (Cr), and lead (Pb) are of particular concern due to their persistence in aquatic ecosystems and potential to bio accumulate in farmed and wild fish ultimately entering the human food chain. This study investigates heavy metal concentrations in *Enteromius paludinosus* (straightfin barb) from River Malewa, a key tributary of Lake Naivasha; an important hub for both capture fisheries and aquaculture. Unlike previous research, this study also examines the role of the parasitic cestode *Ligula intestinalis* in metal bioaccumulation, assessing its potential as a bio-indicator for aquatic pollution. A total of 1,307 fish were sampled at the river mouth, and water, sediment, and fish tissue including *L. intestinalis* were analyzed for heavy metal concentrations using thermal-electron atomic absorption spectrophotometry. While sediment concentrations remained below critical thresholds, fish exhibited elevated levels of As, Cr, Pb, and Hg, with mean concentrations of 5.07, 22.09, 45.21, and 1.55 mg/kg, respectively. Bioconcentration factors confirmed significant metal accumulation in fish tissue, raising concerns over food safety risks for human consumers. Additionally, *L. intestinalis* demonstrated a notable capacity for heavy metal accumulation, with bio-concentration factors of 2.41, 2.19, 5.86, and 5.14 for As, Cr, Pb, and Hg, respectively. These findings highlight its potential use as a cost-effective bio-indicator for monitoring pollution in freshwater systems. This study emphasizes the critical need for enhanced environmental monitoring and robust regulatory frameworks to mitigate heavy metal contamination in aquaculture. Establishing routine heavy metal assessments, adopting best management practices, and enforcing stricter pollution controls are vital for promoting sustainable aquaculture, preserving aquatic ecosystems, and ensuring consumer safety.

INDIGENOUS KNOWLEDGE THAT SUPPORTS SUSTAINABLE MARICULTURE MANAGEMENT IN COASTAL KENYA: THE CASE OF KWALE AND KILIFI COUNTIES

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Indigenous Knowledge (IK) has been observed to be important in supporting development and adoption of technologies globally. Traditional practices like fish traps, mangrove conservation, and tidal knowledge have long sustained marine biodiversity and food security, yet remain under-documented and rarely utilized in modern mariculture developments especially in Kenya. The research aimed to document IK-based mariculture practices, assess contributions to sustainable marine resource management, food security, and explore integration with modern mariculture techniques.

A mixed-method approach, including literature reviews, field surveys, key informant interviews, and focus group discussions with fishers, community leaders, and mariculture experts, was employed using purposive sampling techniques. Four focus group discussions and five key informant interviews were conducted across six sites in Kwale and Kilifi Counties. Qualitative data were analyzed thematically using MAXQDA, and quantitative data were processed using SPSS. Findings indicate that IK-based mariculture technologies enhance sustainable resource management. Demographic insights revealed a dominance of middle-aged practitioners (36-60 years) and limited youth engagement. Qualitative analysis highlighted the reliance on lunar phases, tidal cycles, bird behavior, and indigenous feed production. Challenges on usage of IK was cited as generational knowledge loss, climate change impacts, and weak policy support for usage of indigenous knowledge.

The study recommends formal recognition of IK in mariculture policies (nationally and at local levels), community inclusion in decision-making, and capacity-building programs for knowledge transfer. It emphasizes integrating traditional and modern approaches to enhance food security, promote environmental conservation, and create sustainable economic opportunities for coastal communities.

ISOLATION AND IDENTIFICATION OF BACTERIAL FLORA IN THREE FISH FISH FARMS OF KENYA UNDER DIFFERENT AQUA SYSTEMS

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In Kenya, aquaculture continues to expand as a source of food production and livelihood in all the counties. Mortality of Nile Tilapia and African Catfish fingerlings constitute the biggest loss in extensive and intensive fish farms. The main objective of this study was to determine contamination by bacteria and fungi in Nile Tilapia and African Catfish fingerlings. The study was carried out in fish farms with different water sources, hatchery systems and feed sources. These were; Jambo fish farm in Kiambu County which utilizes borehole water and has a recirculation aquaculture system also known as (RAS). Sagana and Mwea fish farms in Kirinyaga County a rich agricultural county. Four weeks old and weighing 5-7 g, Nile Tilapia (*Oleochromis niloticus*) and African Catfish (*Clarias gariepinus*) 60 each in number were stocked as follows; in every hatchery tank 10 fingerlings of each species regardless of sex. Data obtained from samples was analyzed using descriptive statistics. Live fingerlings samples and fish feeds were collected from three fish farms and taken to the Laboratory. The bacterial load of the samples was determined using the pour plate method. Identification and characterization of various isolates were based on gram-staining technique, biochemical tests and subculture on selective media. Fungi were isolated on SDA agar, Macroscopy of hyphae and mycelium, microscopic identification of subcultured fungal isolates using LCBS stain and Mycology charts. The mean of bacteria isolated in the two fish species from three farms per cfu/mL was as follows: African Catfish had 9.00±3.85a, 27.752.85a and 21.67±4.82a for the Bacillus spp, Escherichia spp and Salmonella spp, respectivelly while Nile Tilapia had 8.58±3.68a, 25.25±3.54a and 22.83±4.95a, for the Bacillus spp, Escherichia spp and Salmonella spp, respectively. Penicillium spp 33.1±2.5cfu/g and Rhizopus spp 27.6±2.8 cfu/g occurred less frequently. There was a significant variation ($p = 0.015$) in the means of bacteria contaminants isolated in Sagana fish farm from Nile Tilapia and African Catfish species. Escherichia spp in the skin did not vary significantly ($P= 0.0684$) between the fish species, however African catfish skin had the highest 27.7±2.8 Escherichia spp contamination. The occurrence of Klebsiella species 22.0±4.7 cfu/ml, Salmonella species 22.80±4.9 cfu/ml, Streptococcus spp 25.0±5.4 cfu/ml while Vibrio spp had a mean of 20.0±3.6 cfu/ml. Formulated feeds had higher contaminations attributable to high moisture, poor storage facilities, handling and preparation methods. For physiochemical parameters,Salinity varied from 155.47±6.49 to 94.70±0.33 mg/L in Sagana and Mwea respectively with Mwea recording the least levels of salinity. Water temperature in the morning ranged from 20.55±0.49°C to 25.30±0.26°C. In the evening time, there was also a significant variation in the levels of temperature with Sagana recording the highest at 27.10±0.63, followed by Jambo 25.00±0.41 and Mwea had the lowest temperature of 20.15±0.43. Variations of salinity, temperature oxygen levels are among the parameters which determine the contamination for the two fish species among the three farms. It is recommended that all farms supplying fingerlings perform frequent assessment of water parameters, fish feeds and water analysis. Fish farmers should be educated on best practices in aquaculture in order to prevent bacterial and fungal contamination.

AQUACULTURE, A FAVORABLE RECOMMENDATION FOR FOOD INSECURITY, POVERTY AND UNDERNUTRITION IN KENYA

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Food insecurity remains one of the most evident aspects of poverty. The growing population and the competition for resources such as land and water imply that global food demand is burgeoning. In Kenya, food insecurity trends are worrying as the population is predicted to hit 55 million by 2030 as the per capita annual growth rate of arable land and the increase in food prices. Aquaculture is vital for enhancing food security, alleviating poverty and promoting sustainable economic growth in Kenya. The main challenges in the aquaculture subsector in Kenya include; Inadequate availability and affordability of quality fish seed (fingerlings), lack of high quality and affordable fish feeds, inadequate supportive infrastructure e.g. hatcheries, fish marketing systems, fish processing plants, shortfall in budgetary allocations to support aquaculture initiatives, weak research- extension-farmer linkages, slow adoption rate of fish farming technologies, innovations and management practices (TIMPs), lack of good credit facilities and schemes for fish farmers, poor security and safety of fish in ponds and cages, poor book keeping and record management leading to inaccurate data, policy and legal framework for fish feed and seed certification to monitor compliance. The opportunities to enhance aquaculture contribution to food security, poverty alleviation and malnutrition in Kenya include; integration of aquaculture into conventional farming, upscaling modern technologies, innovations, and management practices (TIMPs), competency- based training on special skills in aquaculture, organizing fish traders into groups to maximize financial and market opportunities, exploring opportunities in value- added product development, investment in modern fish processing technologies and marketing techniques, promoting public –private partnerships to support aquaculture initiatives.

GONADAL INVESTMENT IN NILE TILAPIA POPULATIONS: A BASELINE FOR SELECTIVE BREEDING IN UGANDAN AQUACULTURE

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Nile tilapia (*Oreochromis niloticus*) is among the most widely cultured fish species globally, valued for its good growth, palatability, high demand, and adaptability to diverse environmental conditions. In Uganda, Nile tilapia dominates the aquaculture sector and ranks as the second most important commercial species after Nile perch (*Lates niloticus*) from capture fisheries. Tilapia farming plays a crucial role in reducing unemployment, food insecurity, and improving nutrition for Uganda's rapidly growing population. Despite its economic potential, tilapia farming faces one of the major challenges of most farmers' inability to access good-quality seed**,** often characterized by poor growth performance. Nile tilapia is naturally distributed across Uganda's water bodies, forming three genetically distinct populations: Albert, Edward-George, and Victoria. However, the reproductive performance of these populations under standardized environmental conditions remains poorly understood. This study aims to fill that gap by providing baseline information on the reproductive traits of these three Nile tilapia populations, offering insights essential for improving the quality of the seed through selective breeding programs.

Methods*:* Thirty hapas (1 m × 2 m × 1 m) were installed in a pond, with each Tilapia population (Albert, Edward-George, and Victoria) of ten families each, randomly allotted to 10 hapas. Each hapa was stocked with a pair of mature broodstock. After 14 days, hapas were checked for swim-up fry, and the broodstock were returned to holding tanks. Fry were fed with a 42% crude protein powdered feed, three times daily. After three months, juveniles were PIT-tagged and stocked into a pond at 4 fish/m^3 for another three months. A sample from each population was then anesthetized and examined for reproductive status.

Results
Under standardized conditions, Nile tilapia from the Albert and Edward female populations exhibited higher gonadosomatic index (GSI) values than those from the Victoria, indicating greater reproductive investment and suggesting superior reproductive potential for selective breeding programs (Fig.1). However, no significant differences were noticed among males (p>0.05).

Discussion: The higher GSI observed in Albert and Edward females suggests enhanced reproductive capacity, highlighting this population's potential suitability for broodstock improvement in Nile tilapia aquaculture.

Conclusion**:** The superior reproductive performance of the Albert and Edward female populations supports their recommendation for selective breeding programs aimed at enhancing seed quality and productivity in Uganda's tilapia aquaculture sector.

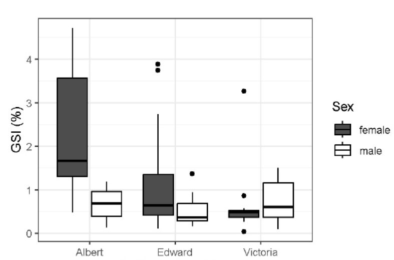

Figure 1 GSI of Nile tilapia populations

AFRICA FISHERIES REFORM MECHANISM FISH TRADE AND AQUACULTURE WORKING GROUP MEETINGS

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The Africa Fisheries Reform Mechanism (AFRM) is the African Union Commission's modality for implementing the Pan-African Policy Framework and Reform Strategy for Fisheries and Aquaculture in Africa (PFRS). The PFRS is the blueprint that guides all policy and developmental actions for the sustainable management and utilization of Africa's fishery and aquaculture resources in concurrence with the Comprehensive Africa Agriculture Development Programme (CAADP).

The impetus for the promulgation of the PFRS and AFRM was initiated by the Council of Africa's Ministers of Fisheries and Aquaculture (CAMFA) in response to the recommendations of the Fish for all Summit that was held Abuja, Nigeria in 2005 and the Africa Heads of State and Government's, Abuja Declaration on Sustainable Fisheries and Aquaculture (2005). Cognizant of the transboundary nature of Africa's aquatic ecosystems, the CAMFA noted unless there was continental coherence in the management of Africa's fishery and aquaculture resources the expectations of the Abuja Declaration on Sustainable Fisheries and Aquaculture (2005) would never be fully realized. To achieve continental coherence for the implementation of the PFRS, they recommended the African Union put in place a mechanism for broad-based participatory continental policy dialogue and fisheries management and support Member States to strengthen policy coherence with respect to the CAADP, in order to enhance the role of fish in food security, poverty alleviation and trade development, as well as a coordination mechanism among Africa's Regional Economic Communities (REC) and Regional Fisheries Bodies (RFB), to ensure coherence of fisheries policies and initiatives with the regional economic integration agenda. Thus, the AFRM serves as an all-inclusive broad-based platform through which all information, knowledge and actions for the sustainable management and development of the sector are channeled and coordinated equitably in a participatory to achieve continental coherence in implementation approaches for the PFRS.

A key element of the AFRM are Working Groups constituting a representation of Africa's fisheries and aquaculture sector value and the multiple stakeholders involved in this chain, right from grass-root level. There are four AFRM working groups, namely: Governance, policy and institutions; aquaculture, small-scale fisheries and fish trade and enterprise development. The working groups collate and synthesize prevailing issues affecting the sector for policy recommendation. These policy recommendations are further deliberated upon by continental think-tank meetings for uptake by policy.

The meetings of the AFRM Working Groups on Aquaculture and Fish Trade and Enterprise Development will be organized as side-event back-to-back with World Aquaculture Safari, 2025 with the objective of identifying opportunities for strengthening prospects for the sustainable development and growth on aquaculture equitably across Africa.

FISH PROTEIN HYDROLYSATES FROM NILE PERCH (*Lates niloticus*) SIDE STREAMS

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Nile perch (*Lates niloticus*), typically found in lakes and rivers in north-east and Central Africa, is industrially processed (smoking, portioning and filleting) in many African and European countries, resulting in large quantities of by-products, namely skin and trimmings. Some of these by-products are composted at local production sites, as they are rich in nutrients such as N, P and Ca, or used to prepare fish silage to be incorporated into animal feed. In importing countries, the main destination is the production of fishmeal and fish oil. Considering that such raw materials may have up to 20% (fresh weight) of protein, another alternative lies in the production of enzymatic fish protein hydrolysates (FPHs), composed by a mixture of non-hydrolysed protein, free amino acids, and peptides with bioactive properties.

Therefore, this study aimed to investigate the potential of FPHs derived from Nile perch trimmings, using an optimised procedure with four different hydrolysis systems: Alcalase in a single step (A), Protana in a single step (P), Alcalase+Protana in a single step (AP) and Alcalase followed by Protana in a two-step process (A_P). The chemical composition and biological activities were carried out on all FPHs, by using well validated methods.

The protein and fat contents (dry weight) in prepared FPHs were between 70-87% and 2.0-3.6%, respectively. The results indicated that the combination of Alcalase and Protana—whether in a single- or two-stage process—significantly improved protein yield (79.7% for FPH_AP and 80.8% for FPH_A_P) and degree of hydrolysis (34.1% and 45.2% for FPH_AP and FPH_A_P, respectively), resulting in peptides with lower molecular weights. Furthermore, hydrolysates produced with the combined enzymes exhibited significantly higher antioxidant and metal-chelating activities compared to those prepared using Alcalase or Protana alone. Additionally, the fractionation of FPH_AP and FPH_A_P enabled the concentration of peptides with molecular weights below 1 kDa, increasing DPPH radical scavenging activity, copper chelating activity and ACE inhibitory activity (166%, 38% and 34%, respectively).

These findings indicate that the four FPHs prepared in this study, exhibit important bioactive and technological properties being valuable sources of nutritional compounds and bioactive peptides. Nevertheless, those obtained with Alcalase and Protana (FPH_AP and FPH_A_P) have greater potential for promising applications in food and nutraceuticals as well in tailor-made feeds.

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THE WELFARE CRISIS OF SALT BATH SLAUGHTER IN AFRICAN AQUACULTURE: CHALLENGES AND THE URGENT NEED FOR HUMANE ALTERNATIVES

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Every year, millions of farmed fish in Africa endure slow and distressing deaths due to outdated slaughter methods. Despite the global push for humane aquaculture, salt bath slaughter—where fish are immersed in hyper-salinity, causing osmotic shock—remains widespread due to its low cost and accessibility. While this method is favored by farmers for its simplicity, mounting scientific evidence reveals that it causes prolonged suffering, erratic swimming, and severe physiological stress before death. This review critically examines the welfare crisis associated with salt bath slaughter, analyzing its impacts on species such as *Clarias gariepinus* and *Oreochromis niloticus*, and highlighting its ethical, economic, and industry-wide implications.

Beyond ethical concerns, the persistence of inhumane slaughter practices poses economic risks for African aquaculture. Stress-induced biochemical changes degrade meat quality, increasing bacterial load and shortening shelf life, ultimately restricting marketability and export opportunities. However, multiple barriers, including economic constraints, lack of farmer awareness, and weak regulatory frameworks—hinder the adoption of humane alternatives. This review explores these challenges and evaluates the feasibility of practical, cost-effective stunning methods such as percussive and electrical stunning, iced-water slurry, and locally adapted stunning tools. Drawing insights from successful case studies in Southeast Asia and Latin America, the study outlines pathways for transitioning African aquaculture toward more humane practices without imposing excessive financial burdens on small-scale farmers.

For Africa's aquaculture industry to thrive, immediate action is needed. Policymakers must integrate fish welfare into national regulatory frameworks, farmers require access to affordable humane alternatives, and researchers should prioritize developing cost-effective stunning methods suited to local contexts. Without urgent intervention, millions of farmed fish will continue to suffer unnecessarily under outdated practices. Humane slaughter is not merely an ethical obligation—it is essential for improving product quality, strengthening industry sustainability, and ensuring African aquaculture remains competitive in global seafood markets. This study calls for a collaborative effort among governments, industry stakeholders, and researchers to drive meaningful welfare reforms in African aquaculture.

COMPARATIVE GROWTH PERFORMANCE OF MARINE TILAPIA (*Oreochromis niloticus, L.)* CULTURED IN HAPA NETS IN DIFFERENT STOCKING DENSITIES USING ANIMAL AND PLANT BASED PROTEIN DIETS

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The growth of aquaculture as an enterprise is hampered by the high cost of fish feed-based protein diets which account for 30-70% of production cost. The need for alternative and cheaper protein sources such as plant-based protein diets is paramount to guide fish farmers on feed efficacy and fish stocking densities. This study focused on the growth performance of fresh water acclimatized Nile tilapia (*Oreochromis niloticus*) using fish meal (animal protein), soybean (plant protein) and wheat bran (control) formulated diets. Nile tilapia fingerlings of 12.5-16.8 g were cultured in hapa nets in three concrete based ponds and in stocking densities of 16 fish/m^3, 11 fish/m^3 and 6 fish/m^3 for each feed treatment. Water quality parameters such as temperature, dissolved oxygen, and salinity were monitored twice a week. Initial and final body length and weight were recorded at the start of culture at and monitored throughout the experimental period on a fortnight basis for 60 days. Two-way ANOVA was used to determine if stocking density and feed treatment(s) had significant effect on fish growth performance. Result shows, weight gain of 11.28 ± 2.79 g was highest on soybean treatment. Stocking density of 6 fish/m^3 recorded the highest percentage survival rate of 84.3 % on wheat bran treatment. The study concludes that Nile tilapia (Oreochromis niloticus) fingerlings had a high feed utilization for soybean meal compared to fish meal and wheat bran and therefore Soybean meal and a stocking density of 6 fish/m^3 can be adopted by farmers in the optimization and maximization of their fish produce. The results of this study can be used to formulate management options for the improvement of fish growth, and enhance food security and address vision 2030.

CAGE CULTURE IN LAKE VICTORIA IS "A DORMANT VOLCANO" YET TO ERUPT: IMPLICATIONS ON FISH WELFARE

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Cage culture in Lake Victoria has emerged as a rapidly expanding aquaculture practice, promising increased fish production to meet the region's growing demand for protein and economic development. However, this growth masks a precarious undercurrent—akin to a "dormant volcano"—with significant implications for fish welfare. Currently, there are >6000 cages erected on the Kenyan side of the lake with mixed reactions from stakeholders on its sustainability. Poor regulatory oversight, high stocking densities, environmental degradation, and limited adherence to best aquaculture practices have created conditions that could erupt into widespread fish health crises and ecological imbalance. This paper explores the hidden risks associated with the current trajectory of cage aquaculture in Lake Victoria. Published literature from peer reviewed journals, unpublished data, scientific reports, and professional opinions from the experts was used in this study. in different parts of the Winam Gulf and further deployment is being experienced amidst cries from resource managers, researchers, policy makers and the community on its sustainability due to increased massive fish kills that have been witnessed in the ecosystem since its inception. Since the deployment of these cages was not informed by any Environmental Impact Assessment (EIA) report, we have an assumption that the lake has no capacity to support cage culture going by its eutrophic state. This study, therefore, aims at reviewing available literature in order to determine whether cage culture is sustainable or not, and thereby offer scientific and professional guidance to inform management. It was confirmed that Lake Victoria has experienced eutrophic and hypertrophic status since 1990, resulting into proliferation of Harmful Algal Blooms (HABs) thus apart from affecting the lake ecology, has led to massive fish kills both in cages and the wild. Further, the situation has been exacerbated by cages whereby 12,487,560 kg of organic matter, 539,400 kg of nitrogen and 171,120 kg of phosphorus is loaded into the lake system each cycle (of 8 months) as organic waste. Consequently, poor water quality has seen massive fish kills both in cages and in the wild causing farmers' losses amounting to >1billion shillings so far. Therefore, without timely intervention, the latent threats may destabilize both the industry and the lake's delicate ecosystem, transforming a promising venture into a source of ecological and socioeconomic strain. We emphasize the urgent need for integrated policies, stakeholder training, and welfare-focused standards in lake-cage culture industry for sustainability.

AQUACULTURE AND THE BLUE ECONOMY IN KENYA: OPPORTUNITIES AND CHALLENGES

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Aquaculture has emerged as a critical contributor to the growth of Kenya's blue economy, offering a sustainable alternative to declining capture fisheries and playing a key role in enhancing food security, economic development, and environmental sustainability. This paper examines the achievements of aquaculture within the context of Kenya's blue economy, highlighting key opportunities and ongoing challenges in the sector's evolution. Kenya has made notable progress in expanding aquaculture production, particularly through government-led initiatives such as the Economic Stimulus Programme (ESP), the Aquaculture Business Development Programme (ABDP), and recently more financial allocation into the sector by the current government under the Bottom up Economic Transformation Agenda (BETA). These efforts have led to increased fish production, food security, job creation, and enhanced income for rural communities thus reducing poverty levels. The promotion of tilapia and catfish farming, along with the development of hatcheries and feed mills, has stimulated local economies and reduced the pressure on overexploited wild fish stocks, contributing to the sustainable use of aquatic resources. It has also provided avenues for inclusive growth, engaging youth and women in fish farming and related value chains. The establishment of aquaculture training centers and extension services has improved technical capacity and awareness among small-scale farmers. Furthermore, innovations in cage farming, integrated aquaculture-agriculture systems, and digital technologies are creating new efficiencies and markets. However, despite these achievements, the sector faces significant challenges: limited access to affordable, quality inputs such as fingerlings and feeds, weak market infrastructure, inadequate cold chain systems, and fragmented value chains. Environmental concerns, including water pollution, poor site selection, and lack of regulatory enforcement, pose threats to long-term sustainability. Additionally, the sector struggles with limited research funding and coordination among stakeholders, which affects policy implementation and innovation. To fully harness aquaculture's potential within Kenya's blue economy, there is a need for integrated policies, increased investment, and stronger public-private partnerships. Emphasizing sustainability, capacity building, and infrastructure development will be essential to overcoming current barriers. Ultimately, aquaculture offers a strategic pathway for Kenya to achieve its blue economy goals by fostering inclusive economic growth, food security, and environmental resilience, provided that the opportunities are effectively leveraged and challenges proactively addressed.

THE FUTURE OF AFRICAN INLAND FISHERIES

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Inland fisheries are crucial for sustenance, livelihoods, and cultural identity across Africa, yet they face challenges from population growth, climate change, environmental degradation, and globalization. This study explores the implications of climate change on African inland aquatic ecosystems, analyzing shifts in fish stock distribution and ecological impacts. A notable case study, the Lake Victoria Small Fish Project (LVSFP), highlights effective strategies for these challenges. The LVSFP promotes sustainable harvesting technologies like solar light fishing instead of kerosene and aims to provide solar driers to reduce post-harvest losses and enhance nutrition security. These initiatives particularly benefit rural communities, with a focus on women and youth. Additionally, digital solutions for data collection and management are being developed within the project. We examine innovative technological solutions, such as digitalization and sustainable aquaculture practices, that can improve the resilience and productivity of inland fisheries. The LVSFP's integration of digital tools serves as a model for similar initiatives across the continent. Our study delves into the complex interplay between ecological, socio-economic, and governance factors, evaluating the effectiveness of community-based management strategies and their contribution to sustainability, as demonstrated by the LVSFP. The necessity of integrated policies that balance conservation with socio-economic needs is emphasized. International collaboration, regional partnerships, and community engagement are identified as critical for shaping a sustainable future for African inland fisheries. The findings aim to inform evidence-based policies, guide further research, and facilitate pragmatic interventions, steering African inland fisheries towards resilience and sustainability.

SPATIO-TEMPORAL DISTRIBUTIONS OF ORGANOCHLORINE PESTICIDES (OCPs) RESIDUES IN EARTHEN FISH PONDS AND RIVERINE ECOSYSTEMS, LAKE VICTORIA BASIN, KENYA (EAST AFRICA)

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A study was conducted over three different seasons in which organochlorine pesticides (OCP) residue water and sediment samples were collected from 14 purposefully selected riverine and earthen fish pond representative sites within Lake Victoria Basin, Kenya, catchment. Extrusion liquids were analyzed for contamination levels using gas chromatograph (equipped with an auto sampler and an electron capture detector (ECD) and confirmed using GC/MS. Main aim was to find out if locally banned or restricted pesticides still find their way into our environment, hence implication on the fragile aquatic ecosystem and human health. Mean concentrations of DDTs, cyclodienes and HCHs in earthen fish ponds' waters were in undetectable to $0.27\pm0.03 \mu gL^{-1}$, undetectable to $0.11\pm0.00 \mu gL^{-1}$, and $4.39\pm1.01 \mu gL^{-1}$ levels respectively; and those in receiving waters were undetectable to $0.23\pm0.01 \mu gL^{-1}$, $1.20\pm0.005 \mu g\ L^{-1}$, and $1.71\pm0.02 \mu gL^{-1}$ respectively. Further, mean contamination by OCPs in sediment samples were noted to be significantly ($p<0.05$) higher in dieldrin ($11.043\pm0.43 \mu gkg^{-1}$), endrin ($4.16\pm0.460 \mu gkg^{-1}$), Heptachlor ($1.61\pm0.02 \mu gkg^{-1}$) DDT ($128.97\pm1.32 \mu gkg^{-1}$), endosulphan ($12.27\pm1.051 \mu gkg^{-1}$), methoxychlor ($37.51\pm 1.641 \mu gkg^{-1}$) and lindane ($8.96\pm1.32 \mu gkg^{-1}$), respectively. An obvious spatial distribution pattern was noted both in water and sediment readings over the sampling period. This demonstrates that cyclodienes are the predominant contaminants and some non-point sources in water courses. Taking $p< 0.05$ as the alpha level, it was observed that there was a statistical significant difference in the residue levels between seasons. The pollution levels in study sites were compared with other studies, suggesting the extraction and analysis method is suitable for long-term on-line monitoring of trace OCPs in aquatic ecosystems. Therefore, continuous studies monitoring OCPs in upstream catchment areas is essential to further understand the future trend of contamination for appropriate policy and management.

FISH STOCK ASSESSMENT IN SHIMONI KWALE COUNTY

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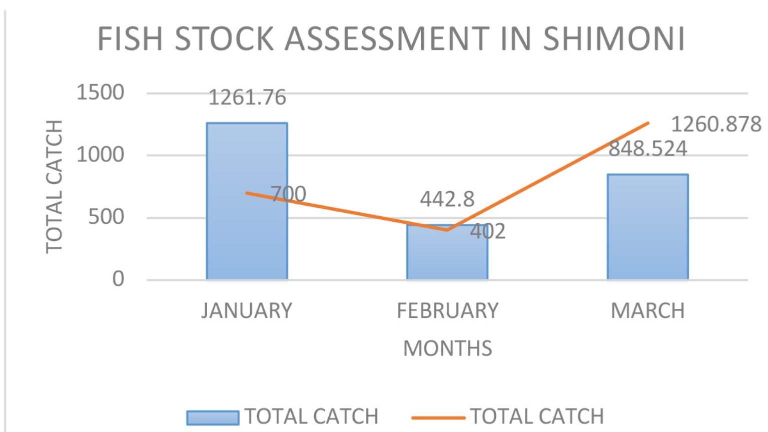
Background: Fish stock assessment is a scientific effort that entails collecting, analyzing, and reporting demographic information to determine changes in the abundance of fishery stocks in response to fishing and predict future trends of stock abundance. The Importance of fish stock assessment is to ensure long term health and productivity of fish stocks, contributing to the sustainability of fishers, helps in conservation and protecting endangered or threatened species and provides information to fisheries management hence helping in setting fishing seasons, quotas and other regulations.

Methods: Interviews and sampling were conducted to the fishers in Shimoni BMU after fishing trips to provide details about fishing grounds, effort and catches during the months of January, February and March of 2024 and the same months for 2025 to compare the trends of fish catch at Shimoni Landing site.

Results: The table shows a summation of the monthly data recorded in the months selected on the given years. Three months which were January to March were selected for the years 2024 and 2025 to show the comparison of the fish catch. According to the results it shows that there is an increase in the fish catch in 2025 compared to 2024.

Conclusion: The results shows that catch levels have increased over the assessment period; however, continued monitoring is essential to ensure sustainability and prevent overexploitation.

YEAR	MONTHS	JANUARY	FEBRUARY	MARCH
2024	TOTAL CATCH	1261.76	442.8	848.524
2025	TOTAL CATCH	700	402	1260.878



ESTABLISHMENT AND OPERATIONALIZATION OF KENYA'S FIRST MARINE HATCHERY FOR INDIAN WHITE PRAWN *Fenneropenaeus indicus*

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A major constraint to the development of sustainable mariculture in Kenya has been the persistent lack of reliable, hatchery-bred seed. For decades, mariculture initiatives by NGOs and donor agencies involving species like prawns, mud crabs, oysters, and seaweeds have struggled to scale due to systemic bottlenecks—including overreliance on seasonally available wild seed, inconsistent quality, and limited technical capacity. This dependency has restricted production planning and long-term viability, reducing most ventures to subsistence levels. To bridge this critical gap, the Kenya Marine and Fisheries Research Institute (KMFRI), with funding from the National Research Fund (NRF), established the country's first marine hatchery at Shimoni in Kwale County.

The facility focuses initially on the Indian White Prawn (Fenneropenaeus indicus), a commercially significant species that comprises over a third (37.2%) of national prawn landings. Broodstock were sourced from semi-industrial trawlers operating in Malindi-Ungwana Bay and induced to spawn via unilateral eyestalk ablation. Two larviculture cycles completed between June and October 2024 produced approximately 60,000 and 600,000 post-larvae (PLs), respectively (Table 1). Larvae were reared using *Nannochloropsis* spp., Artemia (*Artemia franciscana*) and supplemental diets, with PLs from the second run stocked in community ponds—marking Kenya's first structured grow-out trial using hatchery-reared prawns.

Despite early challenges—limited live feed, aeration, and monitoring tools—the trials validated core hatchery operations: broodstock management, larval rearing protocols, phototactic larval collection, and water quality systems. The hatchery now has an estimated production capacity of 4–5 million PLs annually across 6–8 spawning cycles. It also provides a research and training platform through the broader NAMARET initiative, which integrates laboratory facilities, extension training, and seed dissemination.

By enabling year-round seed availability and reducing reliance on wild stocks, the Shimoni hatchery lays the foundation for a scalable, sustainable mariculture sector. It is strategically aligned with Kenya's Vision 2030, the Bottom-up Economic Transformation Agenda (BETA), and regional Blue Economy priorities—positioning the facility as a model for aquaculture growth in the Western Indian Ocean region.

Table 1. Summary of Indian White Prawn Hatchery Performance (June–October 2024)

Parameter	Cycle 1	Cycle 2
Broodstock Spawned	3	30
Post-Larvae Produced (PLs)	~60,000	~600,000
Survival Rate (Estimated %)	Low	Improved
Stocking Density (nauplii/L)	100	100

Key Feed Inputs: Nannochloropsis, Artemia, Commercial Feed

EU-EAC TRUE FISH FARMING STORY IN THE LAKE VICTORIA BASIN (TRUEFISH)

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The Lake Victoria Fisheries Organization (LVFO), of the East African Community (EAC), in partnership with Landell Mills, Food and Agriculture Organization (FAO) of the United Nations and WorldFish is implementing the EU EAC True Fish Farming Story in the Lake Victoria Basin (TRUEFISH) Project. The TRUEFISH project is a significant initiative funded by the European Commission with €10.15 million under the 11th EDF. It benefits the East African community in Kenya, Uganda, and Tanzania over five years, with additional benefits for Burundi and Rwanda in the area of Aquatic Animal Health. The project's goal is to foster competitive, gender-equitable, and sustainable commercial aquaculture in the Lake Victoria basin. It aims to overcome key challenges faced by investors, such as a lack of technically skilled operators, insufficient investment finance, and incomplete networks, while addressing potential threats to sustainable aquaculture development. Key stakeholders, including the aquaculture private sector, TVET institutions, the National fisheries research institutions and national competent authorities.

Currently, the project is at the extension phase. It has facilitated farmers from Burundi, Kenya, Rwanda, Uganda, and Tanzania to conduct study tours to Egypt, Malaysia, Nigeria, Philippines and China where they were exposed to new ideas, technologies, and best practices in aquaculture. The project has organized conferences both online and physical and developed a standardized business plan for Tilapia and Catfish to help fish farmers present credible, bankable business plans and interact more effectively with financial institutions. The project has also worked towards unifying the aquaculture sector by creating a regional aquaculture association. Furthermore, short and long courses have been developed to train aquaculture farmers, students and training of trainers. The Lake Victoria Regional Aquatic Animal Health Strategy has been developed, and spatial planning is underway for the Lake Victoria Zoning for Cage Aquaculture. A study was carried out to assess the genetic diversity of tilapia populations across the Lake Victoria Basin and provided key scientific recommendations for sustainable management of biodiversity in the region. The project has facilitated capacity building to a broader EAC community in various disciplines including fish farming technics, spatial planning for sustainable aquaculture, aquatic health and biosecurity, molecular genetics and bioinformatics. The project is organizing the World Aquaculture Conference in Uganda in June 2025 in collaboration with the World Aquaculture Society.

The EU-TRUEFISH project has catalysed sustainable aquaculture development in the Lake Victoria Basin by addressing barriers in business, skills, and sustainability. Through capacity building, policy harmonization, and regional collaboration, it has strengthened livelihoods and biodiversity. Initiatives like the World Aquaculture Safari'25 aims to position East Africa as a global aquaculture hub.

This project is funded by the European Union

COMPARATIVE STUDY ON THE NUTRITIONAL PROFILE AND HEALTH RISK ASSESSMENT OF CULTURED AND CAPTURED AFRICAN CATFISH *Clarias gariepinus*

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The contribution of aquaculture to human nutrition, consumers' preferential bias towards capture fisheries and concerns on food safety has necessitated the need for information on the nutritional composition of fish species from diverse settings such as geographical locations and aquaculture rearing facilities. This study was conducted to determine and compare the nutritional profile and human health risk assessment of adult size African catfish (*Clarias gariepinus*) cultured in plastic tanks with those harvested from the wild.

This study was carried out using black coloured plastic tanks that were stocked with *C. gariepinus* fingerlings and cultured to table size in five months, with no growth inducing hormone/ treatment administered to the fishes throughout the study. Fish samples (wgt. 800 – 1200 grams) were collected from each of the tank ponds, packed in polyethylene bags and preserved in ice blocks and were taken to a National reference analytical laboratory for analysis.

Results showed the mean protein and lipid values of cultured *C. gariepinus* were significantly higher than reported values in *C. gariepinus* from the wild (Table 1), while captured fishes reported higher ash content, mineral composition and trace metal contents (Table 2)

Health risk assessment indicated the absence of non – carcinogenic risk (HI <1) and carcinogenic risk (ICR $< 1 \times 10^{-4}$) associated with the consumption of cultured *C. gariepinus*. While captured fishes reported high hazard index values (HI > 1) indicating associated health risk to consumers. With increasing concerns on aquatic food safety due to water pollution, this study has shown that the consumption of cultured *C. gariepinus* is more nutritious and guarantees food safety to consumers.

TABLE 1: Analytical values of the nutritional composition of Cultured *C. gariepinus*.

	Plastic Tanks	Owan River	Ikpoba Reservoir	P - Value
Proximate Composition (%)				
Moisture	65.62^{b}	68.00^{b}	61.09^{a}	$p < 0.05$
Protein	18.04^{b}	16.52^{a}	15.15^{a}	$p < 0.05$
Fat	8.71^{b}	7.18^{a}	6.03^{a}	$p < 0.01$
Ash	3.00^{a}	3.56^{a}	4.58^{b}	$p < 0.05$
Mineral Composition (mg/100mg)				
Na	0.96^{a}	4.29^{b}	4.87^{b}	$p < 0.05$
K	2.61^{a}	7.36^{b}	8.56^{b}	$p < 0.05$
Mg	1.33^{a}	2.67^{b}	3.87^{b}	$p < 0.05$
Ca	3.51^{a}	3.43^{a}	5.13^{b}	$p < 0.05$
Fe	3.10^{a}	4.84^{b}	7.43^{c}	$p < 0.05$
Zn	1.15^{a}	2.05^{b}	3.16^{b}	$p < 0.05$

Table 2: Analytical values of the Trace metal contents in Cultured *C. gariepinus*.

mg/ 100mg	Plastic Tanks	Owan River	Ikpoba Reservoir	P - Value
Cu	0.38^{a}	0.45^{a}	1.82^{b}	$p < 0.05$
Mn	0.35	-	-	-
Ni	0.017	-	-	-
Co	0.015	-	-	-
Cr	0.0014	-	-	-
Pb	0.0011^{a}	0.003^{a}	0.015^{a}	$p > 0.05$
Cd	0.0003^{a}	0.002^{b}	0.004^{b}	$p < 0.05$

STOCK STATUS AND SOME BIOLOGICAL ASPECTS OF BIG BLUE OCTOPUS *Octopus cyanea* Gray 1849 AT THE SOUTH COAST OF KENYA

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INTRODUCTION

Octopuses are marine mollusks belonging to Phylum Mollusca, Family Octopodidae. They inhabit shallow tropical, subtropical, and temperate waters worldwide.

In the Western Indian Ocean region, two common species (*Octopus cyanea* and *Octopus vulgaris*) are recorded in Kenyan fisheries. This study aims to provide updated information on fishery dynamics, stock status, and biological aspects of octopus.

POPULATION STRUCTURE OF *Octopus cyanea*

Preliminary results indicate that 99% of octopus caught were *Octopus cyanea*, with a total landed catch of 1,724 kg.

STUDY AREA

Shimoni, located on Kenya's south coast. Representative samples were taken for length and weight measurements, with dorsal mantle length (DML, cm) measured from the midpoint between the eyes to the posterior tip of the body. Sex was recorded for each specimen.

SEX RATIO & MANTLE DISTRIBUTION

Mantle length distribution (N = 1,319) was analyzed using 5 cm length intervals.

- Mean mantle length (±SE): 8.27 ± 0.07 cm
- Northern Monsoon (NEM): 8.793 ± 2.432 cm
- Southeastern Monsoon (SEM): 8.229 ± 2.574 cm

A t-test showed significant variation ($p<0.05$, $t = 1.9832$, $t_c = 1.9618$). The sex ratio among 1,319 specimens was 1 female: 0.8 males.

DISCUSSION

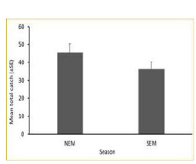
Findings suggest *Octopus cyanea* is abundant in this region. Catches vary across fishing grounds in terms of size and quantity. Seasonal variations indicate octopus is caught throughout the year. Effort and catch rates are higher during the Northern Monsoon season.

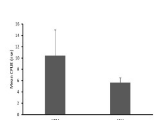
CONCLUSION

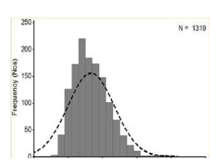
Regular assessments are necessary to ensure responsible fisheries management. Findings suggest *Octopus cyanea* is the most abundant species in Kenya's south coast.

ACKNOWLEDGMENTS

Special thanks to Kenya Marine & Fisheries Research Institute and The Technical University of Mombasa for their support and mentorship.







MARINE FISH FARMING IN KENYA'S COASTAL REGION: STATUS, CHALLENGES, AND EMERGING OPPORTUNITIES

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Kenya's coastal region, with its 640 km coastline, boasts abundant natural resources, including suitable water temperatures, coastal lagoons, and extensive mangrove ecosystems, ideal for Mariculture. Despite these advantages, marine fish farming remains underdeveloped, with production far below its potential.

A study across five coastal counties was conducted to evaluate the status, challenges, and opportunities in Mariculture. Data was collected from 46 Mariculture groups across five counties using structured questionnaires in the Kobo Collect tool. From the findings, Key species farmed include milkfish (*Chanos chanos*), mullet (*Mugil spp.*), salt-tolerant tilapia, mud crab (*Scylla serrata*), artemia (*Artemia franciscana*), prawn (*Penaeus monodon*), and seaweeds primarily small-scale and relies on traditional methods.

From the findings the key challenges include financial constraints, inadequate seed supply, poor-quality inputs, security threats and underutilization of the pond infrastructure while low returns from sales were the least cited issue. Growth is further hindered by the lack of sampling equipment, supportive policies, quality marine-specific feeds, and climate change impacts like rising sea levels and temperature shifts.

Despite these obstacles, opportunities exist to revitalize Mariculture. Increased investment in hatcheries, research, and locally sourced, cost-effective feeds can enhance productivity. Capacity-building initiatives for youth and women could improve skills and create jobs. Supportive policies and partnerships between public and private stakeholders can foster a favorable environment for growth. Innovations such as integrated multi-trophic aquaculture (IMTA) and climate-resilient practices offer sustainable pathways.

As at 2023, out of the Mariculture production, seaweeds stood at 97.76% while production from shellfish combined with finfish was approximately 2.24%. To scale up from pilot to commercial levels, adopting existing technologies and engaging coastal communities and private partners is crucial. The development of a mariculture suitability map could identify optimal areas for species farming, supporting the Blue Economy agenda.

Addressing these challenges and leveraging opportunities can significantly improve livelihoods and drive sustainable development in Kenya's coastal communities.

IMPROVED FARMED FISH-DRYING: POTENTIALS FOR TECHNOLOGICAL INNOVATION AMONG FISH PROCESSORS IN KENYA

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Dried fish are widely distributed and affordable, and in some instances eaten whole or uncooked, which is nutritionally beneficial since fish bones and eyes are particularly rich in proteins and micronutrients, and further cooking processes, if not well controlled, lead to protein denaturation. Further, solar-based dried fish do not contain the harmful levels of PAHs (polycyclic aromatic hydrocarbons) found in traditionally smoked fish, and their processing does not require any fuel wood or fossil energy. A great potential—both economically and nutritionally—therefore lies in improving and marketing healthy and environmentally friendly solar-dried farmed fish products. This paper presents initiatives to improve the quality of dried farmed fish produced in a recirculating aquaculture system (RAS) in Kenya by use of a combined solar drying system under development. The solar-based fish products produced under sanitary and phytosanitary conditions are to be tested in the market and enabled to access national and regional retail stores. The inventiveness, if well received, will have a great impact on the environment where the fish processors enthusiastically receive new technology and products, but upscaling and ownership remain a challenge. A follow-up research to identify factors likely to limit the combined solar drier wider spread resulting in lasting innovations. These factors include: Sanitary conditions, low capacity during bumper fish production, preference for equipment ownership, land access, credit needs, demand for quality products, and stringent fish quality requirements to reach high end markets. In light of the long history of interventions to introduce new fish processing technologies, we discuss the need for focusing on improved solar drying technology and appropriate adaptability to local socio-cultural and economic contexts.

GROWTH AND SURVIVAL RATE OF CATFISH (*Clarias gariepinus*) FRY FED ON KENYAN-PRODUCED AND IMPORTED ARTEMIA WITH SUBSEQUENT WEANING OF DRY FEEDS

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Culture of fish fry is highly dependent on live feeds. In Kenya, hatchery owners and fish farmers use phytoplankton or *Artemia* as their main live feeds. Phytoplankton is collected in pond water while *Artemia* is imported or produced locally. Complaints of low survival rates of fry from farmers and hatcheries using imported *Artemia* necessitated this study. A 21-day experiment was conducted to evaluate the growth and survival rate of *Clarias gariepinus* fry fed on Kenyan produced and imported *Artemia* cysts. The experiment was conducted in twelve (12) glass aquaria (60cm*30cm*30cm) filled to a capacity of 30 L randomly placed at the hatchery. Four hundred and fifty *C. gariepinus* fry of approximately 0.02gms and 6mm were counted randomly and introduced in each aquaria at a stocking density of 15 fry/l. The fry were fed exclusively on *Artemia* diet from day 2 to 8 of the experimental period. On day 9 to 11, the fry were co-fed on *Artemia* and dry feed to prepare them for the starter diet which was a dry feed. After the three days, the dry feed was introduced from the 12th day to the end of the experiment. The feeds were administered three times a day at a four-hour interval at 09.00, 13.00 and 17.00 hours. Results indicate that water quality variations had minimal influence on the growth and survival of *Artemia*. On the other hand, there were no significant differences in body length among treatments. However, there was a significant difference in body weight on day 7 among the treatments. A significantly higher survival rate ($p < 0.05$) was observed in larvae fed on the decapsulated Shell Free *Artemia* 21 days compared to the other two encapsulated treatments. Growth results demonstrate that 7 days of live feeding is sufficient for efficient rearing of catfish larvae. The decapsulated *Artemia* is having had better growth recommended for a higher survival rate of fish fry. It is also recommended that other factors be explored in future experiments such as nutrition and the feeding rates of *Artemia* on fish fry.

ASSESSMENT OF THE IMPACTS OF HUMAN ACTIVITIES ON MARINE FISHING GROUNDS, A CASE STUDY OF MTWAPA CREEK IN KILIFI COUNTY

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This study investigated the impacts of human activities on the marine fishing grounds along Mtwapa creek. The research study employed survey design, in which the researcher distributed both open-ended questionnaires and closed questionnaires to the respondent. The study population was divided into two clusters that is, marine officers and community fishermen. The sample size was 36 respondents, which is 30% of the target population. 21 respondents were selected from the community fishermen while the remaining 15 respondents were selected from marine officers. From the data collected it is evident that overfishing was the human activity that was rated the highest with 31% (20), closely followed by boat riding with 30% (19), dumping of waste in the ocean was rated third with 25% (16) and lastly, agricultural practices with 14% (9). On the Impacts of human activities marine fishing grounds, the study found that reduction of fish stock and loss of fish habitat were rated the highest with 26% (21), closely followed by loss of biodiversity and extinction 25% (20), and lastly pollution with 23% (19). The study concludes that different human activities were practiced in the study area with the main one being overfishing. Other activities practiced along Mtwapa Creek included dumping of waste, agricultural practices and boat riding. The effects of dumping of wastes into the ocean results into pollution this killing aquatic life. Agricultural activities also contributed to pollution of the ocean because of reliance on fertilizer application to improve yields and due to the methods of weeds and pests control used on the farms. All these practices negatively impact marine fishing grounds resulting in loss of biodiversity and extinction of some species.

HEMATOLOGY, OXIDATIVE STRESS AND BIOCHEMICAL RESPONSES IN *Clarias gariepinus* POST FINGERLINGS EXPOSED TO SUBLETHAL DOSES OF EMAMECTIN BENZOATE

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Emamectin benzoate (EMB) is a highly neurotoxic insecticide used in agronomy, animal husbandry, and farming of aquatic organisms to control pests. Runoff from these sources can harm fish. In this work, experimental groups were subjected to four doses of 17 $\mu g\ L^{-1}$, 34μgL^{-1}, and 68 $\mu g\ L^{-1}$, and control without EMB for 14 days, after which fish was monitored for one week (7 days) depuration period to estimate recovery potential of the fish. In days 1, 7 and 14 durations of exposure, stress biomarkers including aspartate aminotransferase (AST), alkaline phosphatase (ALP), alanine aminotransferase (ALT) and blood Urea and Creatinine levels increased with dose and duration, and after 7 days depuration period, they maintained elevated values. The antioxidant enzymes superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx) decreased significantly ($p < 0.05$), as did packed cell volume (PCV), mean corpuscular volume (MCV), hemoglobin concentration (Hb), and red blood cell count (RBCC). The trend continued after 7 days of depuration. There were significant ($p<0.05$) leukocytosis, lymphopenia and neutrophilia in treated fish. In contrast, lipid peroxidation and glutathione reductase (GR) levels increased but returned to normal after 7 days of depuration. The altered hematological parameters were indicative of immune suppression and anemia in the exposed fish, while the altered antioxidant enzymes implied that reactive oxygen species (ROS) may have played a role in the toxic action of EMB. This study showed that7 day depuration time was insufficient to repair the harm caused by EMB stress to the fish.

DOES CAGE CULTURE INFLUENCE DISEASES, WHAT ARE BEST PRACTICES AND REFLECTIONS FOR SUSTAINABLE AQUACULTURE ON LAKE VICTORIA, KENYAN WATERS?

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Lake Victoria and has potential to close the fish supply deficit in the region and provide other employment and income. However, if not appropriately guided and regulated, cage aquaculture could become unsustainable, causing conflicts with other water uses, environmental degradation and economic losses to aquaculture enterprises. To enhance other benefits like continuity cage culture we need a proper inventory on cage culture disease management for sustainable development of aquaculture. The cage aquaculture fish mortalities are prevalent and pose economic shocks with catastrophic livelihood impacts, particularly for small-scale farmers in the lake. A consistency approach of sampling water quality wherever there is fish kills. A rapid-response health investigations was done on tilapia mortality testing of bacterial pathogens. There were 7 fish kills recalled from 2024 with total mortalities exceeding 1.2 million tilapia; yet, only 45% of farmers reported to Kenyan Low dissolved oxygen levels showed an indication of isolation of Aeromonas jandaei, Enterobacter hormaechei, and Staphylococcus epidermidis with implication of suspected causes for a tilapia mortality event in Anyanga. The study identified bacterial pathogens from a fish kill at Anyanga of Lake Victoria. Fish disease surveillance detected trichodinids and monogeneans as common external parasites. With critical implications for guiding fish health management husbandly in Lake Victoria. The study identified bacterial fish pathogens via active disease surveillance and conduct antimicrobial resistance testing in Lake Victoria.

CLIMATE- AND HUMAN-MEDIATED FATE OF THE *Lates* PERCHES OF LAKE TANGANYIKA INFERRED USING GENOMICS

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Lake Tanganyika houses the most species diversity among the African Great Lakes. Its fishery is dominated by six endemic pelagic species, including four *Lates spp.*, three of which are threatened (Figure 1). However, fishing pressure and climate change are causing a decline in the abundance of these species, consequently threatening their persistence. How these populations are responding to fishing pressure and climate change remains unclear. Coalescent-based genomic tools and fossil data can provide insights into recent demographic histories of these pelagic populations, highlighting evolutionary trends at community and genomic levels in response to fishing pressure and climate change. The current research will evaluate these dynamics using modern genomics and fossil data.

Both climate change and/or fishing pressure are predicted to result in low genetic diversity (*p*) and low effective population size (*Ne*) as signatures of declining populations as contrasted with high *p* and *Ne* for stable or expanding populations (Figure 2). However, similar *p* and *Ne* trends among species will indicate shared environmental factors shaping their evolution, in contrast, different trends will indicate the effect of each species' genetic background termed *idiosyncratic epistasis*. Finally, declining fossil abundance will reflect evolutionary change in past community assemblages due to climate change.

Findings will support the formulation of evidence-based policies for the sustainable management of the Lake Tanganyika ecosystem, as well as the broader African Great Lakes and other freshwater ecosystems, in the face of climate change and increasing human impact. Finally, detected genomic signatures of adaptation will inform national, regional, continental, and global aquaculture strategies to meet the future demand for fish protein.

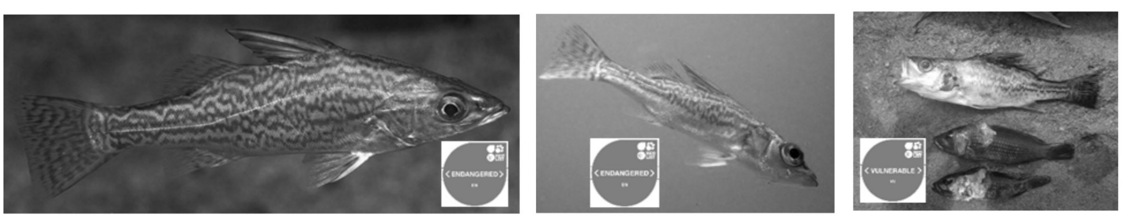

Figure 1: IUCN status of *Lates angustifrons*, *Lates microlepis*, and *Lates mariae*, respectively

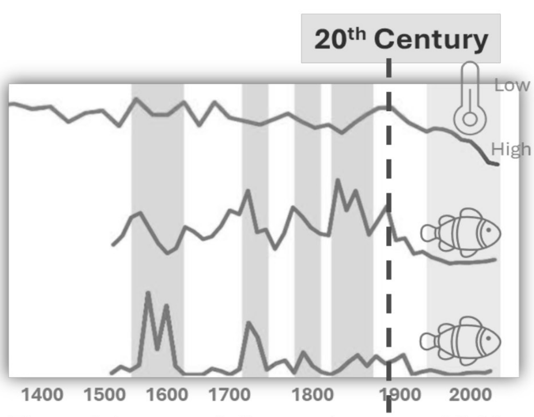

Figure 2: Impact of climate change and fishing pressure at the genomic level (Modified from Cohen et al., (2023).

PERFORMANCE of *Clarias gariepinus* FINGERLINGS FED BAOBAB AND TAMARIND PULP POWDERS AS SUSTAINABLE ALTERNATIVE TO SYNTHETIC VITAMIN-MINERAL PREMIX

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This study evaluated baobab (*Adansonia digitata*) and tamarind (*Tamarindus indica*) pulp powders diets. A completely randomized design was used to test five experimental diets; a 3% SVMP, 5% and 7% baobab pulp powder, and 5% and 7% tamarind pulp powder. Three hundred fingerlings were assigned to 15 experimental units with 20 fish/tank and fed at 3% body weight for 12 weeks.

Fish fed baobab-based diets (5% and 7%) showed similar weight gain and feed efficiency to those on SVMP, while tamarind-fed fish had lower growth and feed conversion efficiency, indicating poor nutrient utilization. Hematological analysis found no significant differences in red blood cell counts, hemoglobin, or packed cell volume between baobab-fed and SVMP-fed fish, suggesting adequate physiological function. However, tamarind-fed fish exhibited anemia and physiological stress, likely due to tannins and phytates inhibiting nutrient absorption.

Baobab pulp powder appears to be a viable SVMP alternative, supporting growth, hematological stability, and favorable water quality. However, tamarind pulp powder requires further processing to reduce anti-nutritional factors. Future research should explore fermentation and enzymatic treatments to improve nutrient bioavailability and feed efficiency.

Table 1. Growth performance and nutrient utilization

	Experimental diets					
Parameters	SVMP (3%)	BPPVM (5%)	TPPVM (5%)	BPPVM (7%)	TPPVM (7%)	P-values
Initial weight (g)	5.54±0.01	5.53±0.06	5.54±0.02	5.52±0.12	5.53±0.11	0.275
Final Weight(g)	105.60±0.09^{a}	104.86±0.13^{a}	77.14±0.04^{b}	105.24±0.21^{a}	77.05±0.42^{b}	0.000
Weight gain (g)	100.06±0.08^{a}	99.33±0.27^{a}	71.60±0.02^{b}	99.72±0.09^{a}	71.52±0.11^{b}	0.000
SGR(%/day)	3.27±0.03^{a}	3.27±0.22^{a}	2.93±0.2^{b}	3.27±1.08^{a}	2.93±0.21^{b}	0.005
FCR	1.09±0.21^{a}	1.12±0.14^{a}	3.81±0.33^{b}	1.17±0.53^{a}	3.24±0.31^{b}	0.000
PER	1.90±0.82^{a}	1.90±0.14^{a}	1.83±1.21^{b}	1.90±0.41^{a}	1.83±0.21^{b}	0.001
Survival	100±0.23	100±0.04	90±0.12	100±0.16	92±0.11	0.850

Table 2. Hematological Indices of catfish fed different diets

	Experimental diets					
Parameters	**SVMP (3%)**	**BPPVM (5%)**	**TPPVM (5%)**	**BPPVM (7%)**	**TPPVM (7%)**	**p-values**
RBC (CellsX10^{12})	2.72±0.39^{b}	2.86±0.21^{a}	2.38±0.32^{c}	2.80±0.20^{a}	2.40±0.10^{c}	0.000
WBC	23.21±0.52^{a}	22.50±0.21^{b}	22.62 ± 0.17^{b}	23.05±0.13^{a}	22.83±0.43^{b}	0.002
Hb(gldl)	9.28±0.17^{b}	9.83±0.20^{a}	8.07±0.48^{c}	9.62±0.31^{a}	8.73±0.38^{c}	0.000
PVC(%)	24.90±0.89^{a}	25.22±0.29^{a}	22.20±0.05^{b}	25.75±0.78^{a}	22.80±0.07^{b}	0.000
MCV(fl)	91.54 ± 0.33^{b}	88.18±0.26^{b}	93.27±0.28^{c}	91.96 ± 0.44^{b}	95.00±0.46^{a}	0.000
MCH(pg)	34.11±0.25^{a}	34.37 ± 0.33^{a}	33.90±0.50^{b}	34.35±0.23^{a}	36.38±0.55^{b}	0.000
MCHC(%)	37.26±0.18^{b}	39.00±0.50^{a}	36.35±0.20^{c}	37.35±0.49^{b}	36.71±0.33^{c}	0.000

THIS STUDY ASSESSED THE UTILIZATION OF BOATS FOR FISHING ACTIVITIES WITHIN THE FEDERAL CAPITAL TERRITORY (ABUJA), NIGERIA

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Observations and interviews with fishermen along the riverbanks revealed the prevalent use of various canoe and speed boat types, ranging from basic vessels to small motorized boats, for both diurnal and nocturnal fishing. Traditional fishing methods remain common, including the deployment of fishing nets such as cast nets, seine nets, and gillnets (reported by 85% of interviewed fishermen), as well as the use of hand lines and rods with baited hooks 60%. Fish traps or pots were also utilized by a smaller proportion of fishermen 30 %.

The study examined the operational aspects of these methods, the resources required, and their perceived effectiveness. Notably, fishermen often employed nets in conjunction with two boats to encircle fish, while calabash gourds were utilized for buoyancy and movement in the water 70% reported using calabash). Fishermen strategically identified cooler areas and observed fish feeding patterns (e.g., on insects and bread used as bait) to optimize their catch. Instances of decomposed organic matter attracting fish into nets were also noted.

The research indicates that crayfish constituted the majority of the catch reported by the fishermen approximately 75% of the total catch by weight although other unidentified species were also present. Fishermen reported peak fishing times to be early morning and late at night when fish activity was perceived to be higher. The study highlights the need for further research to identify the diversity of fish species present and recommends documenting best practices in the local fishing techniques.

OPPORTUNITIES FOR JOB CREATION ACROSS INTEGRATED MULTITROPHIC AQUACULTURE VALUE CHAIN IN KENYA

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This study explores the potential of Integrated Multi-Trophic Aquaculture (IMTA) to drive sustainable job creation along Kenya's coastal counties—Kwale, Mombasa, Kilifi, Tana River, and Lamu. By leveraging the region's rich marine biodiversity and existing aquaculture practices, the report identifies how IMTA—an ecologically balanced system that co-cultivates species across different trophic levels—can provide environmental, social, and economic benefits. The research highlights region-specific opportunities, particularly the role of women and youth in aquaculture/mariculture and the potential for diversification of income sources in underdeveloped counties. Through structured field data collection, training of enumerators, and community engagement, the study emphasizes IMTA's ability to enhance local livelihoods, reduce environmental footprints, and foster climate resilience. Ultimately, the adoption of IMTA is presented as a viable pathway for inclusive blue economy development in Kenya's coastal belt.

PROFITABILITY OF SMALL-SCALE AQUACULTURE: A TALE OF THE UNPROFITABLE PROFITS

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This study examines the profitability of small-scale aquaculture producers using farm-level data from a national survey of catfish farmers in Nigeria. Farmers were categorised by production scale—micro, small, medium, and large—based on total output. A distinct group of micro-scale farmers was identified, representing 52% of the sample and 63% of the small-scale category. Profitability was assessed using multiple metrics: absolute profit, return on investment (ROI), operating profit margin (OPM), and profit per kilogram.

Average costs increase with scale of operation with feed cost being the highest across all operational scale (Table 1). While the overall results suggest that aquaculture is generally profitable, deeper analysis highlights the multifaceted nature of small-scale profitability. Micro-scale farmers reported positive net profit, but their ROI, profit per kg, and OPM were significantly lower than those of other groups and fell well below the overall relative average (Table 2). These results indicate that, despite making a profit in absolute terms, the margins are minimal and unlikely to sustain long-term viability. Supporting this, survey responses show that many farmers exiting the industry cite high production costs or a lack of meaningful profit as key reasons.

The findings underscore the importance of scale-specific analysis and the use of multiple profitability indicators in assessing economic performance. To ensure the sustainability of the aquaculture sector, especially for the most vulnerable operators, there is a clear need for targeted policy support and programme interventions aimed at improving the profitability of micro- and small-scale producers.

Table 1. Average cost estimates of catfish production by scale of operation.

Cost Items	Micro	Small	Medium	Large
Fingerlings cost (N)	43,029	117,249	253,313	542,567
Feed cost (N)	593,781	1,783,660	4,323,556	8,925,670
Labour cost (N)	54,352	156,714	252,513	373,030
Other costs (N)	49,436	106,488	191,290	469,773
Variable cost	**740,599**	**2,164,111**	**5,020,671**	**10,311,040**
Depreciation of Owned	2,841	3,946	13,838	38,428
Rent	6,732	12,923	14,639	20,000
Fixed cost	**9,573**	**16,870**	**28,478**	**58,428**
Total cost	**750,172**	**2,180,981**	**5,049,149**	**10,369,468**

Table 2. Performance and profitability indicators of catfish production by scale of operation.

Indicators	Total Average	Micro	Small	Medium	Large
Revenue	2,874,986	925,557	2,851,825	7,214,021	15,906,489
Gross Margin	789,187	184,958	687,713	2,193,350	5,595,448
Profit	773,207	175,385	670,844	2,164,872	5,537,021
Variable cost/kg	627.80	682.48	578.97	557.13	536.10
Fixed cost/kg	10.38	14.79	6.58	4.24	4.10
Total cost/kg	638.19	697.27	585.55	561.37	540.20
Profit/kg	126.60	71.32	164.48	214.87	250.59
Product price	765	769	750	776	791
ROI (%)	28.55	19.08	34.45	44.83	49.56
OPM (%)	14.84	7.37	20.08	26.71	30.29

Financial estimates were in Naira ₦ ($1 = ₦306; (Central Bank of Nigeria, 2023)

TISSUE CULTURE OF *Gracilaria verrucosa* FOR SUSTAINABLE PRODUCTION OF AGAR IN KENYA

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The main objective of this study was to carry out tissue culture of *Gracilaria verrucosa* for production of adequate seedlings with desirable qualities for mass seaweed production that will sustain a viable agar industry in Kenya. Four tissue culture experiments were carried out during the present study period, with emphasis on regeneration, contamination and survival of cultured explants. Explants were excised from native *G. verrucosa* samples from Kibuyuni study site in south coast Kenya and surfaced sterilized with 10% sodium hypochlorite solution before being cultured in Murashige and Skoog (MS) basal medium in combinations with varied plant growth regulators such as; gibberelic acid (GA_3) kinetin (6-furfurylamino) purine, 2,4-dicholorophenoxyacetic acid (2,4-D), and indole-3-acetic acid (IAA) in concentration ranges of 0, 0.5,1.0, and 1.5 mg L^{-1}. Culture medium without PGRs was used as the control.

Experiment 1 was monitored for period of 16 weeks while experiment 2 for 20 weeks. Explants cultured in medium supplemented with IAA at 0.5 mg L^{-1} concentration level exhibited highest shoot regeneration efficiencies of 67, 100 and 67 % after 8, 12 and 16 weeks of culture period respectively in experiment 1, and shoot regeneration efficiencies of 0, 67, 100 and 100% after 8, 12, 16 and 20 weeks of culture periods respectively in experiment 2. Similarly, explants cultured on medium with GA_3 enrichment at 1.5 mg L^{-1} concentration level in experiment 1 exhibited the highest shoot regeneration efficiencies of 100, 33 and 67 % during 8, 12 and 16 weeks of culture periods, and 100% shoot regeneration efficiency in all respective culture periods in experiment 2. The results suggest that tissue culture of *G. verrucosa* is possible if contamination of cultures can be minimized through frequent observation of the cultures.

ADVANCING ETHICAL AND SUSTAINABLE AQUACULTURE IN AFRICA: A CALL TO ACTION

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Aquaculture is Africa's fastest-growing food production sector, offering enormous potential for food security, rural development, and economic growth. Yet, the continent's aquaculture systems face urgent challenges related to fish welfare practices and associated regulatory oversight. Addressing these challenges is essential for enhancing production efficiency, minimizing disease outbreaks, and ensuring long-term industry viability.

This presentation will highlight the critical role of fish welfare in advancing sustainable aquaculture, exploring how welfare-centered practices improve fish health and survival, reduce losses, support environmental stewardship, and align African aquaculture systems with evolving international trade requirements and sustainability standards. The presentation will also showcase the Africa Fish and Aquaculture Welfare (AFIWEL) Program, a pan-African initiative designed to bridge knowledge gaps, strengthen policy frameworks, build professional capacity, and support market access for the integration of fish welfare practices into sustainable aquaculture systems. The program promotes a holistic approach that aligns animal welfare with food security, environmental sustainability, and economic growth. Insights from pilot activities across eight African countries will demonstrate how targeted, scalable interventions can drive improvements in farming practices, policy engagement, and value chain development, ultimately fostering more ethical, resilient, and sustainable aquaculture systems in Africa.

Participants will gain practical insights into integrating fish welfare into national and regional aquaculture strategies, positioning African producers for improved sustainability, market competitiveness, and investment readiness.

LEVERAGING ARTIFICIAL INTELLIGENCE FOR FISH HEALTH AND AQUACULTURE ADVISORY IN AFRICA

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Aquaculture in Africa is rapidly expanding, yet many fish farmers continue to face challenges in accessing timely, and expert guidance on fish health, disease management, and welfare best practices. Limited access to quality veterinary and aquaculture professionals, knowledge gaps, and poor farm-level decision-making continue to constrain productivity and sustainability across the sector.

This presentation will introduce RORE, an AI-powered, multilingual One Health chatbot developed to bridge this gap by delivering real-time, expert-informed aquaculture and fish health advisory to farmers, extension workers, and stakeholders. Built on artificial intelligence and natural language processing, RORE provides personalized information, support, and referrals (where relevant) on fish welfare, disease symptoms, feeding, water quality, and responsible antimicrobial use via digital channels including WhatsApp and web platforms.

The session will explore how RORE was conceptualized and developed with contribution from the pan-African Africa Fish and Aquaculture Welfare (AFIWEL) program, how it is being piloted with fish farmers in Africa, and its potential to enhance farmer decision-making, reduce mortality, and support ethical and sustainable aquaculture systems. The presentation will also share early user feedback, lessons learned and future integration into aquaculture production and value chain systems.

SCALING FISH WELFARE FOR SUSTAINABLE AQUACULTURE IN AFRICA: THE JOURNEY FROM RESEARCH TO REGIONAL ACTION

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Aquaculture is the fastest-growing food production sector in Africa, with immense potential to strengthen food security, boost rural livelihoods, drive economic growth, and promote environmental sustainability. However, despite this rapid expansion, fish welfare remains significantly overlooked in policy development, training programs, and farm-level operations. This neglect has constrained the sector's sustainability, productivity, and ethical accountability. Bridging this gap is critical for improving production efficiency, reducing disease outbreaks, and ensuring the long-term viability and global competitiveness of African aquaculture. One Health and Development Initiative (OHDI) has emerged as a leading advocate for fish welfare in Africa, beginning with foundational research and pilot training efforts in Nigeria. In response to growing regional needs, OHDI launched the Africa Fish and Aquaculture Welfare (AFIWEL) Program, a pioneering pan-African initiative designed to integrate fish welfare into sustainable aquaculture systems through capacity building, policy advocacy, and systems innovation. Since its inception, AFIWEL has mobilized a network of AFIWEL Fellows across eight African countries and successfully hosted the first Africa Aquatic Animal Welfare (AQUAWEL) Conference, convening stakeholders from policy, academia, civil society, and the private sector. This presentation will highlight AFIWEL's key milestones, including the integration of RORE, an AI-powered digital assistant providing real-time fish health and welfare guidance to farmers, as well as national training rollouts, and stakeholder engagements. Looking ahead, the program is laying the foundation for a continent-wide ethical aquaculture framework anchored on five strategic pillars: policy integration, stakeholder training and capacity building, improved market access for welfare-compliant fish, strengthened public-private partnerships, and heightened public awareness. This presentation will share actionable insights, replicable models, and engagement opportunities, while also reflecting on the challenges and transformative potential of advancing animal welfare within African aquaculture systems.

VULNERABILITY OF FISHERFOLKS IN COASTAL AND FRESHWATER FISHING COMMUNITIES, LAGOS STATE

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Fisheries play a crucial role in Nigeria's socio-economic landscape, supporting the livelihoods of over 150 million Nigerians. However, fishing activities is being altered among which is climate change. Climate change has been threatening fishing activities through environmental event, disproportionately impacting vulnerable fisher folks, with gender inequalities playing a crucial role in understanding these distributive impacts. The study addresses the vulnerability of fisher folks in coastal and freshwater fishing communities Lagos State, Nigeria,

Primary data was collected through structured questionnaires from fisherfolks using Multi-stage (three stage) sampling technique. Simple random technique was used to select 240 fisher folks from the population of fishermen in both coastal and freshwater fishing communities. Data was analyzed using descriptive statistics (mean, percentage, standard deviation), Harvard analytical framework and Inferential statistics (T- test)

Results from socio-economic reveal that 38.79% and 41.93% of the fisherfolks were under 46 years from coastal and freshwater area respectively. With varying educational levels, coastal areas showed 56.90% (53.49% male :66.67% female) with no formal education, while in the in freshwater regions 35.48% (42.53% male: 18.91% female) with senior secondary education. The household size of 6-12 members was observed in both communities with over 10 years of fishing experience. Vulnerability varied across different indices, socio-demographic profile (SDP), freshwater areas are more vulnerable (SDP $_{\text{coastal regions}}$ 0.41; SDP $_{\text{fresh water}}$ 0.58), for Livelihood strategies, coastal regions scored higher (0.65) than freshwater region (0.54), social networks indicators were greater for coastal (0.75) than freshwater region (0.65), health vulnerability score for fresh water areas (0.77) was higher than coastal regions (0.72), the overall food vulnerability score for fresh water households (0.33) was greater than coastal regions households (0.30). For water, Coastal had (0.44) while freshwater had (0.16), for natural disasters, coastal area (0.73) are more than those in the freshwater areas (0.56). Overall, coastal regions had a higher livelihood vulnerability index (LVI) than freshwater regions (0.571 versus 0.513).

The study observed that both fishing environments are experiencing substantial climate impacts, with coastal regions experiencing slightly more pronounced effects. Coping and adaptation strategies were similar in both regions, the study therefore calls for targeted interventions that recognize gender-specific experiences, enhance community resilience and provide comprehensive support mechanisms.

SUSTAINABLE SPIRULINA PRODUCTION USING ALKALINE LAKE WATER (LAKE SIMBI) AS AN ALTERNATIVE PROTEIN SOURCE FOR STARTER FISH FEED

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In aquaculture, feed constitutes over 50% of operational costs, with fishmeal being the primary, yet increasingly expensive, protein source. Spirulina (*Arthrospira sp*) is a highly nutritious cyanobacterium which is rich in protein, vitamins, minerals, and antioxidants. Thus, it is suitable for human consumption, animal feed among other uses. Despite the conviction that the superfood holds the keys to unlocking the future of nutritional and food security challenges, its large-scale cultivation is often constrained by high production costs and resource-intensive methods. Further, little has been done to exploit the natural alkaline lake water, for Spirulina cultivation. This study investigates the potential of cultivating Spirulina using nutrient-rich alkaline water from Lake Simbi as a sustainable, cost-effective protein alternative for fish feed.

The experiment, conducted at KMFRI Sangoro in Kisumu County, evaluated Spirulina growth under varying concentrations (0%, 25%, 50%, 100%) of Zarrouk's medium—both targeted and untargeted. Water samples were analyzed for physico-chemical properties to determine limiting nutrients.

Results indicated that while Lake Simbi water alone supported Spirulina growth, nutrient levels, particularly nitrogen, phosphorus, and potassium were significantly lower than literature values. Highest biomass yields, 1.22 g/L, were recorded in tanks with 100% Zarrouk and 50% untargeted feed, while cost-efficiency was highest in tanks with 0% feed. However, nutrient depletion limited long-term productivity in feedless setups. Moderate supplementation (50% Zarrouk) provided sustainable yields and maintained a healthy culture.

The study findings suggest that Lake Simbi water can partially support *Spirulina* cultivation, offering potential for localized, low-cost fish feed production. Further studies are necessary to explore alternative cost-effective nutrient enhancement for sustained productivity.

ACOUSTIC TARGET STRENGTH MODELING OF *Caridina nilotica* TO IMPROVE BIOMASS ESTIMATES FOR SUSTAINABLE AQUACULTURE, FISHERIES, AND CONSERVATION IN LAKE VICTORIA

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Caridina nilotica (Roux, 1833) holds considerable potential for supporting local aquaculture in Lake Victoria, particularly in fish feed formulations. Accurate biomass estimation is essential for sustainable exploitation, yet current harvesting strategies are hindered by uncertainties in abundance and ecological sustainability. Traditional hydroacoustic surveys have relied on inappropriate target strength (TS) models based on morphologically dissimilar Antarctic shrimp, leading to unreliable biomass estimates. This study presents a species-specific TS model for *C. nilotica (Caridina)*, developed using the Distorted Wave Born Approximation (DWBA) as implemented in ZooScatR. Geometric and morphometric parameters were derived by digitizing images of fresh *Caridina* specimens, generating a consensus shape catalogue. These inputs, combined with species-specific and environmental material properties, were used to simulate TS values at 70 and 120 kHz—frequencies routinely employed in Lake Victoria acoustic surveys. Predicted TS values at 120 kHz for *Caridina* ranging from 2 to 25 mm varied between –127.87 and –71.91 dB re-1 m^2, with a mean length-weighted TS of –87.99 dB re-1m^2. Backscattering intensity was isolated using dB differencing (5–10 dB range), and biomass was calculated using a derived TS per kilogram of –37.76 dB re-1m^2 kg^{-1} (95% CI: –40.12, –35.17). Lake-wide biomass estimates showed an increasing trend, from 957,467 metric tonnes (95% CI: 853,094–1,066,303 MT) in 2007 to 1,596,668 metric tonnes (95% CI: 1,467,788–1,725,245 MT) in 2022. These results are consistent with depth-stratified patterns observed in fish landing data. The revised estimates are consistently higher than those obtained using previous methods and better reflect ecological expectations, including support for higher predator abundance, greater lake productivity, and the feasibility of commercial *Caridina* exploitation. The development of a robust TS model marks a key advancement in hydroacoustic biomass estimation, enhancing our understanding of Lake Victoria's food web and supporting data-driven fisheries and aquaculture management.

DATA-DRIVEN INSIGHTS INTO ENHANCING AQUACULTURE PRODUCTIVITY AND INCOME: THE ROLE OF SOCIO-DEMOGRAPHIC FACTORS, FARM AND MARKET CHARACTERISTICS IN KENYA

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Aquaculture is emerging as a critical strategy to meet rising food demand and alleviate poverty in Africa, particularly as capture fisheries decline due to overexploitation, pollution, and climate change. In Kenya, the Aquaculture Business Development Programme (ABDP) has been a major public investment aimed at enhancing fish production and income among smallholder farmers. However, despite standardized inputs and training across counties, disparities in productivity and income persist, suggesting that other underlying factors may be influencing outcomes. This study investigates the influence of socio-demographic factors, farm characteristics, and market access on aquaculture productivity (kg) and income (USD) among 927 smallholder farmers across 15 counties participating in ABDP. The objective was to determine which human and contextual factors most significantly impact production and sales outcomes in a standardized aquaculture intervention. Data were collected using structured digital surveys administered via Kobo Toolbox, and analyzed using log-log linear regression models to interpret elasticities and significance of multiple predictors. Key findings reveal that education, fish species, variable input costs, and regional location significantly influenced both production and income levels. For instance, a 1% increase in variable input costs was associated with a 2.8% increase in fish production and a 9.4% increase in income. Farmers in Western Kenya exhibited higher productivity than those in Central/Eastern regions, while those selling to institutional and hotel markets achieved higher incomes. Socio-demographic factors such as gender and household size had limited direct influence on outcomes when controlling for other variables. These results suggest that beyond input provisioning, aquaculture outcomes are shaped by market dynamics, farmer knowledge, and regional conditions. We recommend strengthening farmer education, tailoring regional interventions, and enhancing access to high-value markets through inclusive value chains. Policy shifts towards differentiated support based on farmer profiles and location could improve aquaculture's contribution to food security and rural livelihoods in Kenya.

SPIRULINA CULTURE FOR FOOD AND NUTRITIONAL SECURITY IN KENYA

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Hunger and malnutrition remain an issue in Kenya, with 81% of the population unable to afford a decent meal. When cultured, Spirulina, a highly nutritious microalga, plays an increasingly important role in improving food and nutrition security, combating hunger, and increasing the resilience of the food system. Spirulina, which is high in protein (55-70%), vitamins, minerals, and antioxidants, provides a long-term solution to malnutrition, especially in susceptible groups including children, pregnant women, and persons with compromised immunity. Food security is achieved when all people have access to safe and nutritious food to live a healthy and active life, which has proven challenging in most parts of Kenya. Spirulina can survive with little water and land, making it suitable for climate-resilient agriculture. Cultured spirulina has been utilized for a variety of purposes, including malnutrition prevention, health and wellness, and immunological boosters for vulnerable groups, including children and people living with HIV/AIDS. A few small-scale private Spirulina farms and non-governmental organizations in Kenya are promoting its production and consumption, but national output remains low, necessitating imports from Malaysia, India, and China. In Kenya, various Rift Valley alkaline lakes can be used as sources of Spirulina seeds/culture, since the presence of Spirulina in these sources has been verified; however, the best strain for culture in Kenya is yet to be identified. As a result, selecting the best strain, increasing knowledge to enhance production among Kenyans, and incorporating Spirulina into national nutrition programs could improve its acceptability and impact. The INNOECOFOOD project is identifying the best strain for mass production at the community level in an ecohub to assure the availability and affordability to local populations, thereby addressing undernutrition in the most vulnerable groups. Furthermore, tightening policies, increasing investment, and incorporating Spirulina into national nutrition programs could improve Kenya's food and nutrition security, as well as public health.

ADOPTION OF CLIMATE-SMART FEEDS FOR IMPROVED AQUACULTURE PRODUCTION AMONG SMALLHOLDER FARMERS IN RURAL KENYA

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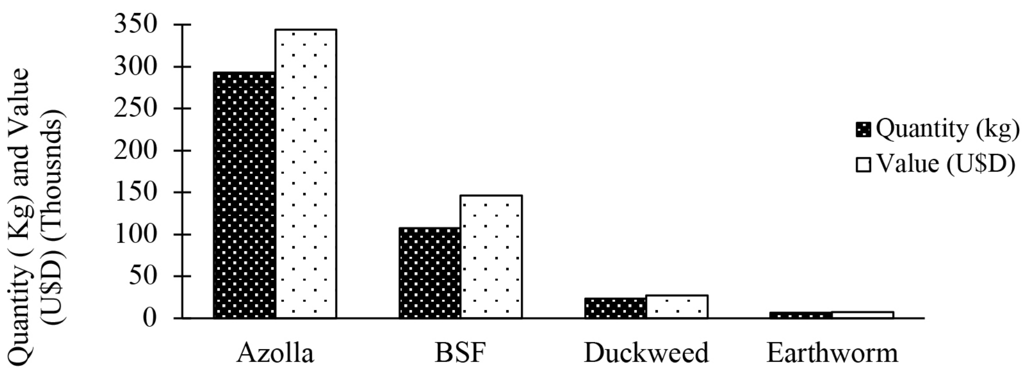
Fish feed is the most expensive input for any aquaculture enterprise due to the use of fish meal fish oil and soybeans which are very costly. Additionally, use of soybean has been contributing to deforestation and ecological disruption thereby leading to climate change issues, affecting the aquaculture sector. This study evaluates the production and utilization of mosquito fern (*Azolla pinnata*), black soldier fly (*Hermetia illucens*) larvae (BSF), duckweed (*Lemna minor*) and Earthworm (*Eisenia fetida*) as an alternative feed for aquaculture in Kenya. The main objective is to address the challenges arising from declining fish stocks and unsustainable aquaculture practices reliant on fish meal and commercial pellets. The study involved 297 smallholder farmers in 14 counties implementing the Aquaculture Business Development Program (ABDP) in Western, Nyanza and Eastern and Central region of Kenya. A descriptive research design was adopted, and a survey was conducted to collect data on the adoption of the various feeds. Results indicated that most fish farmers who were adopting climate-smart feeds were middle-aged groups (78%) and were mainly male (73%). The most adopted feed was *A. pinnata* which was produced and utilized in all the counties with a total of 343,816 kg with a value of USD 292,535 being produced. The feed with the highest increase in fish production was BSF which led to an increase in production by 50% due to its superior nutritional value. This study also highlights the importance of incorporating these climate-smart feeds to reduce the utilization of commercial feeds which rely on fish meal and soybean to enhance environmentally sustainable aquaculture.



INNOVATION AND TECHNOLOGY THE KEY TO AQUACULTURE TRANSFORMATION IN EAST AFRICA

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Aquaculture in East Africa holds vast potential to enhance food security, create employment, and drive economic growth. However, the sector remains underdeveloped, contributing less than 10% to the region's total fish supply despite increasing demand projected to reach 2.5 million metric tons by 2030. The adoption of innovative technologies presents a pivotal opportunity to transform this sector. Precision aquaculture, digital farm management tools, and recirculating aquaculture systems (RAS) can increase productivity by up to 35%, reduce input costs by 20%, and improve fish survival rates by 25%. Mobile-based platforms have already begun connecting over 50,000 smallholder fish farmers with real-time data on water quality, disease outbreaks, and market access. In countries like Kenya and Uganda, smart hatchery innovations have led to a 40% improvement in fingerling quality and availability. Despite these gains, barriers such as limited access to finance, poor infrastructure, and low digital literacy persist. Unlocking aquaculture transformation in East Africa will require strategic investments, public-private partnerships, and supportive policy frameworks. Cage aquaculture is an innovative approach whose contribution to aquaculture production is at over 60%, while alternative feed ingredients such as Black Soldier Fly and aquatic macrophytes have a 30% cost reduction potential though not yet fully tapped. By scaling innovations and leveraging digital technologies, East Africa can bridge the fish demand-supply gap, improve livelihoods, aquaculture production catchment, contribute to national GDP and establish itself as a competitive player in the global aquaculture market.

ENHANCING EFFICIENCY IN FINGERLING PRODUCTION IN LAKE VICTORIA BASIN USING THE RECIRCULATORY AQUACULTURE SYSTEM

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The Lake Victoria Basin, a critical hub for aquaculture in Kenya, faces significant challenges in fingerling production, including water scarcity, poor water quality, and high mortality rates. This paper evaluated the potential of recirculating aquaculture systems to enhance efficiency in fingerling production by optimizing water use, improving growth conditions, and minimizing environmental impact. The technology integrated mechanical and biological filtration, automated oxygenation, and waste management to maintain optimal water parameters (dissolved oxygen >5 milligrams per litre, ammonia <0.5 milligrams per litre, nitrite <0.3 milligrams per litre), crucial for fingerling survival and growth.

A six-month comparative analysis between traditional pond systems and recirculating aquaculture systems was conducted at the Kibos Integrated Technology Transfer Centre in Kisumu County, focusing on tilapia (*Oreochromis niloticus*) fingerling production. Results demonstrated a 35% increase in survival rates, a 25% reduction in water usage, and improved fingerling quality. The technology also achieved a higher specific growth rate of 3.2% per day compared to 2.5% in ponds, alongside a better feed conversion ratio of 1.1 versus 1.4. Economic analysis revealed a 20% reduction in operational costs per fingerling due to lower disease incidence and reduced water exchange.

The findings demonstrated that recirculating aquaculture systems could enhance small to medium-scale aquaculture enterprises by ensuring consistent fingerling supply, minimizing ecological impact and improving profitability, therefore, contributing to regional food security. The study recommended policy support and training initiatives to promote widespread adoption for sustainable aquaculture development.

ASSESSING THE EFFICACY FISHERIES CO-MANAGEMENT AMIDST THE IMPACTS OF CLIMATE CHANGE-A STAKEHOLDER PREPAREDNESS EVALUATION OF LAKE VICTORIA FISHERIES KENYA

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There is a common agreement that establishment of co-management could be of benefit to fisher community and other stakeholders across the African Great Lakes. This studo examined the efficacy of community-level fishery co-management organizations called Beach Management Units (BMUs) along the Kenyan shores of Lake Victoria in the wake of the impacts of climate change. Data were collected from 5 BMUs along the Kenyan shores of Lake Victoria. A total of 99 respondents and 20 key informant interviews were done in all the 5 riparian counties of Lake Victoria. Descriptive and inferential analyses were performed using excel and **R-4.4.0.tar.gz**. Data was collected through site observations, and questionnaire led interviews involving the key informants and Beach Management Units' members. The study reveals that main causes of climate change are defforestation(82%), Industralization (43%), rainfall (23%) and GHGs (21%) while the main consequences are food insecurity (64%), Drought (60%), rainfall (57%), fish stock change (56%) and poor human health at (52%) .Survey result indicate that 93.9% (Figure 5) of the respondents are aware of climate change. Despite majority of the respondents being aware of climate change, only 34.4% agreed on evidenced climate change impacts adaptation strategies within the co management framework. The study reveals that it's not clear weather climate change issues get integrated in the co-management framework with committee members (38%), BMU leaders (50%) says not integrated while 58% of the fish traders doesn't know. BMU committee members, BMU leaders, fish traders, fisherman and other categories were rated 50%, 50%, 35%, 28%, 42% respectively to somewhat believe that there is community education on climate change and co-management issues. The low rating of such measurable attributes advocates lack of effectiveness of co-management in Lake Victoria, Kenya. This was attributed mainly to lack of continuous awareness creation amid the changing lake environmental conditions and dynamics in the specific species fishery. There is need to sustain the achievements so far attained in promoting co-management and ecosystem sustainability, as enforcement of laws and regulations can be a challenging undertaking without government support. Governments should ensure financial and material provision in expanding capacity of co-management units in promoting community livelihoods and fishery sustainability.

SAMAKI POA: STRENGTHENING AQUACULTURE THROUGH VOCATIONAL TRAINING – REFLECTING ON THREE YEARS OF IMPACT ACROSS EAST AFRICA

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Over the past three years, the Samaki Poa project has worked closely with partners across the aquaculture value chain—including training institutions, hatcheries, feed suppliers, and farms—to bridge a critical gap in practical aquaculture training across East Africa. In a region where fish demand is rapidly outpacing supply, building a skilled workforce is essential. Yet, many young professionals lack access to hands-on, quality training that reflects the day-to-day realities of modern fish farming. Samaki Poa tackles this challenge by embedding vocational aquaculture modules within existing training centers, input supply hubs and the expanding a growing network of Aquaculture Academy campuses.

Launched in 2021 and funded by Norad, the project has established a robust practical training ecosystem across Kenya, Uganda, and Rwanda. More than 1000 trainees have now completed Samaki Poa-led training programs, gaining key competencies in farm management, water quality, biosecurity, and business operations. All curricula are tailored to local production systems, with a focus on Nile tilapia and African catfish.

Through a “learning by doing” approach, participants go beyond theory—getting their hands in the water during single or multi-day trainings led by experienced aquaculture trainers. In each country, Samaki Poa works with local experts to ensure training reflects national contexts and nuances. Participants include a diverse mix of farmers, students, marine fishermen, and fisheries officers. Training levels are adapted to meet the needs and capacities of each group, ensuring relevance and impact.

The project has also expanded its training infrastructure, including the recent launch of the Rangwe Campus in Homa Bay County, Kenya. This innovative training hub—built inside a recycled shipping container, powered entirely by solar energy, and located on an operational farm—demonstrates a circular, context-driven approach to vocational training. With capacity to train over twenty participants at a time, the site is designed to serve the region long after the project’s end.

Inclusion is a core focus of Samaki Poa, with proactive efforts to engage women and youth and improve access to capacity-building opportunities through local partnerships. Three years in, Samaki Poa has demonstrated that practical, locally anchored vocational training is a powerful driver of growth in East Africa’s aquaculture sector. It boosts employability, stimulates entrepreneurship, and contributes meaningfully to food security, rural livelihoods, and sector professionalization.

In this session, we reflect on the lessons learned and share the vision for what lies ahead.

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GENERAL CONTINENTAL OUTLOOK OF POLICY DIRECTION OF AU ON FISHERIES AND AQUACULTURE

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The Fisheries and Aquaculture resources of Africa provide essential benefits to over 10 million people, most of whom are rural poor. These benefits include food security, improved nutrition, and enhanced livelihoods. However, they are currently under severe threat due to weak and uncoordinated institutions, as well as ineffective fisheries governance and policies. Poor governance has led to the over-exploitation of commercially important fish stocks, limiting resource sustainability and reducing the sector's contribution to food security, poverty alleviation, and wealth creation. Despite its high potential and current rapid growth in Africa, Aquaculture is still faced with numerous challenges that needs to be address or mitigated in order for it to play effective role in filling the gap in supply from capture fisheries.

African Union Recognized the urgent need for reform in Fisheries and Aquaculture sector and and went ahead to make various high-level political declarations and commitments to restoring fisheries to their maximum sustainable yields and sustainably develop Aquaculture sub-sector. Some of these commitments includes but not limited to the one made at the World Summit on Sustainable Development (WSSD) in 2015, the Abuja Declarations of African Heads of Government at the Fish for All Summit in 2014, and resolutions from the Conference of African Ministers of Fisheries and Aquaculture (CAMFA). These continental initiatives have led to the development of the Policy Framework and Reform Strategy for Fisheries and Aquaculture in Africa (PFRS) and the establishment of the African Fisheries Reform Mechanism (AFRM) as its delivery mechanism. The PFRS serves as a blueprint for facilitating sustainable Fisheries and Aquaculture development in Africa.

One of the key policy objectives is aimed at "realizing the full potential of the aquaculture sector to generate wealth, social benefits and contribute to the development of the African economy by jumpstarting market-led sustainable development strategies". This is implemented through the continental 10-year plan of action for sustainable aquaculture development, a companion document to the PRFS as well as the Comprehensive Africa Agricultural Development Programme (CAADP) Malabo and Kampala declaration.

To support the implementation of the PFRS, the African Union-Inter-African Bureau for Animal Resources (AU-IBAR), through a series of interactive consultations process, developed 'A Guide for the Implementation of the Policy Framework and Reform Strategy for Fisheries and Aquaculture in Africa'. This guide was formulated through a rigorous, consultative and participatory process involving key stakeholders, including AU Member States (AU MS), Regional Economic Communities (RECs), specialized regional fisheries and aquaculture institutions, non-state actors (NSAs), AFRM members, development partners, and independent experts. It serves as a complementary document to the PFRS, providing practical guidance for its implementation.

The African Fisheries Reform Mechanism (AFRM) was developed to create a new, coherent, AU-based regional partnership platform - with the objective of facilitating the development, adoption and implementation of reforms in fishery governance and management that would contribute towards transforming Africa's fisheries from overexploitation and overcapitalization towards environmental, economic and social sustainability as well as planning for and facilitating sustainable development of Aquaculture in Africa. The AFRM was concurrently endorsed with the Policy Frame Work for Fisheries and Aquaculture in Africa (PFRS) by the 2014 Summit of Heads of States and Government in Equatorial Guinea.

The revised AFRM Architecture was endorsed by Summit of Heads of States and Governments in February 2020 in Addis Ababa, Ethiopia and it now serves as a platform for Coordination and coherence; Information sharing; Knowledge generation among others.

(Continued on next page)

Within the policy generation function of the revised African Fisheries Reform Mechanism (AFRM), four working groups were established and constituted:
1. Governance, Policy and Institutions
2. Sustainable Aquaculture Development
3. Small-Scale Fisheries Development and Management
4. Fish Trade and Enterprise Development

To support the implementation of PFRS using AFRM, AU-IBAR is currently implementing Fisheries Governance Phase 2 (FishGov2) under the program "Enhancing Sustainable Fisheries Management and Aquaculture Development in Africa. A Program for Accelerated Reform of the Sector. This project is being supported by European Union with the main aims to align activities with the objectives and principles outlined in key AU declarations, recommendations, and resolutions, including those of the AFRM and PFRS as explained above. A key outcome of the project is to ensure coherent implementation of the PFRS at continental, regional, and national levels.

The Specialized Technical Committee (STC) on Agriculture, Rural Development, Water and Environment (ARDWE) was established as one of the 14 African Union' STCs by the Decision of the 12th Ordinary Session of the African Union Assembly (Assembly/AU/Dec.227 (XII)) which was held in Addis Ababa, Ethiopia from 1st to -3rd February 2009. The STC, as a ministerial Committee is composed of Ministers and senior officials from African Union Member States responsible for the sectors falling within its areas of competence.

Functionally, the AFRM provides input into the African Union Specialized Technical Committee (STC-ARDWE) on Agriculture, Rural Development, Water and Environment. Hence FishGov2 Project provided for an activity to simplify and operationalize the AFRM including to facilitate meetings of the revised WGs on formulation of experts' inputs on emerging issues in fisheries and aquaculture.

Since then, the four Working Groups of the AFRM have identified and articulated many important knowledge products including Policy briefs, Advocacy notes. In particular, the Sustainable Aquaculture development working group has so far developed (number of policy briefs and advocacy notes, -Create a link to those documents)

CURBING FISH LARVAL MORTALITY AND IMPROVING IMMUNITY; THE INCLUSION OF PREBIOTICS IN DIETARY FEED FOR AFRICAN CATFISH (*Clarias gariepinus)* AND NILE TILAPIA (*Oreochromis niloticus)*

Kwabena Derick Owusu

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Larval mortality is a great challenge to the aquaculture industry. The larval stage has characteristics which make them susceptible to a lot of unfavourable conditions, including (1) Lack of fully functional immune system (2). Lack of fully functional digestive system (3). Compromised osmotic system and host microbe interaction (Faruk & Anka, 2017; Phelps, 2010; Rehman et al., 2017; Vadstein et al., 2013). Research has proved prebiotics as a good source of nutrient to boost immune development across a wide range of fish. This article is focused on the potential benefits of including prebiotics in the diet of larval Nile tilapia (*Orechromis niloticus*) and the African catfish (*Clarias gariepinus*).

In the studies of Abdel-Tawwab et al (2008), tilapia fry fed with 1.0-5.0g/kg yeast supplemented diet had significant effect on whole-fish body composition except for the moisture content. This was attributed to increased fish appetite due to the yeast supplementation. After challenging the fish with *A. hydrophila*, the fry fed with yeast supplementation especially 5.0g/kg had low mortality as compared to those fed with control diet. Similar observation has been made in several fish species such as *Labeo rohita* (Chandra et al., 2006), *Piaractus mesopotamicus* (Hamilton et al., 2017), *Orechromis niloticus* (Sherif et al., 2019; Dawood et al.,2020).

Several studies have enumerated the benefits and mode of work of prebiotics. Google scholar indicates about 18,300 research articles from 2000 to 2024 on beta-glucan alone use in fish. The use of prebiotics has therefore been identified to boost growth, feed conversion, improve health status, increase stress resistance among others. The factors influencing the effect of immunostimulant application can be dosage, length of application, mode of application, stage of growth of fish and health conditions of fish.

More research is needed in the African context on the extended effects of prebiotics in larvae, the dosage and the best modes of application to elicit the needed response.

COMPARATIVE DISEASE RESISTANCE IN THE PREDOMINANTLY CULTURED AFRICAN CATFISH SPECIES IN NIGERIA; *Clarias gariepinus*, *Heterobranchus longifilis*, AND THEIR HYBRID

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Anecdotal evidence from fish farmers in Nigeria suggests that the hybrid of *Clarias gariepinus* (female) and *Heterobranchus longifilis* (male) are hardier to diseases, and have higher survival and growth rate when compared to their parent species. There is the need to validate this assumption and elucidate the factors that may contribute to disease resistance observed in the hybrids.

Twenty juveniles each of *Clarias gariepinus* (Group A), *Heterobranchus longifilis* (Group B) and the hybrids of *Clarias gariepinus* (female) and *Heterobranchus longifilis* (male) (Group C), were acclimatized for two weeks under the flow-through system. The fishes were fed to satiation, twice daily using commercial catfish diet. Blood samples were collected from ten fish samples in each group for haematology, and samples of the liver, spleen, kidney, gills and posterior intestine were also collected for histology. *Aeromonas carviae* isolated from a moribund fish in a clinical case and identified biochemically using Vitek 2- Compact (BioMerieux) was used for experimental infection of the three fish species by immersion, in 1.5×10^8 cfu per ml of the isolate at a rate of 5ml/L. MacFarland's standard (0.5) was used for the bacteria count. Gross lesions and mortality were observed and recorded for 14 days. Blood samples and tissue samples were also collected from the surviving fish for haematology and histopathology respectively.

The pre-infection comparison of the Mean (±SEM) WBC, Lymphocytes and Eosinophils counts across the three groups were significantly different (p value < 0.05). The hybrids had the highest value in Mean (±SEM) WBC, Lymphocytes and Eosinophils counts followed by the *Clarias gariepinus*, while *Heterobranchus longifilis* had the least values. The pre-infection histology revealed normal tissue structures in the organs. The post-infection comparison of the Mean (±SEM) WBC, Lymphocytes and Eosinophils counts across the three groups were not different significantly (p value > 0.05). There were histopathological lesions observed in the three groups. These lesions include diffuse hepatic degeneration and coalescing, loss of gill lamellae core and mucosal arrangement, and diffuse tubular degeneration and ballooning in the renal tissue. Other organs did not have histopathological lesions. Mortality was recorded post-infection in Group A (*Clarias gariepinus*) only, although all the groups had mild clinical signs and gross lesions. Comparing the pre-infection and post-infection haematology, the differences in the Mean (±SEM) lymphocytes and eosinophils were significant (p value < 0.05) with the hybrids having the highest increase, followed by *Heterobranchus longifilis* while *Clarias gariepinus* had the least increase.

These results show that the hybrids have better immune response to infection as evidenced in the highest increase in lymphocyte count. This also shows that the adaptive immunity plays a major role in the line of defense against bacterial infection in African catfish species.

STRENGTHENING AQUACULTURE SKILLS THROUGH TECHNICAL AND VOCATIONAL EDUCATION TRANSFORMATION: THE TRUEFISH MODEL IN EAST AFRICA

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The “True Fish Farming Story in the Lake Victoria Basin” project (TRUEFISH), funded by the European Union under the 11th European Development Fund (EDF11) and implemented by the Food and Agriculture Organization of the United Nations (FAO), has pioneered a strategic model for developing aquaculture skills in East Africa through the transformation of Technical and Vocational Education and Training (TVET) institutions.

Working with the Ramogi Institute of Advanced Technology (RIAT) in Kenya, the Fisheries Education and Training Agency (FETA) in Tanzania, and the Fisheries Training Institute (FTI) in Uganda, the project adopted a structured, country-led process beginning with institutional and sector-wide Training Needs Assessments (TNA). These informed individual workplans that were later aligned regionally to define three key intervention areas: (1) infrastructure improvement and equipment provision for training delivery; (2) strengthening the capacity of TVET teaching staff through regional and international Training-of-Trainers (ToT) programmes; and (3) development and certification of aquaculture curricula, including upgraded diploma programs and 12 standardized short courses.

Following institutional strengthening, short-term training was delivered to over 510 aquaculture farmers in collaboration with national aquaculture associations—the Aquaculture Association of Kenya (AAK), the Aquaculture Association of Tanzania (AAT), and the Uganda Aquaculture Cooperative Union Ltd (UACU). All courses were taught by TVET instructors previously trained through the project’s ToT programme, ensuring technical alignment and pedagogical consistency.

Crucially, National Focal Points (NFPs) from participating countries were actively engaged throughout the process—from planning and content validation to monitoring and delivery—thus securing national ownership and policy coherence. With accredited courses, trained staff, and operational facilities, the three institutions are now positioned to deliver continued aquaculture training, ensuring a sustained pipeline of qualified aquaculture professionals in the Lake Victoria region.

THE WORLD BANK AQUACULTURE DIGITAL ROADMAP

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Presentation at the World Bank Special Day: Enhancing Aquaculture Potential in Africa: Insights, Innovations, and Investment through the AquaInvest Platform

The “Digital Roadmap for Aquaculture Promotion and Development” – or Aquaculture Digital Roadmap – was prepared for the World Bank by a team from AquaBioTech Group and FutureFish during 2024 through a series of in-depth stakeholder consultations within and outside the Bank. The funding for the project was provided by PROBLUE, a multi-donor trust fund managed by the World Bank that supports sustainable and integrated development of marine and coastal resources in healthy oceans, and PROGREEN, the Global Partnership for Sustainable and Resilient Landscapes. The Roadmap highlights the role of aquaculture as a strategic priority for World Bank investment and unlocking its potential towards achieving SDGs and addressing global challenges of poverty reduction, unemployment, sustainable and healthy food systems and the climate and biodiversity crisis. The roadmap provides the justification, vision and strategy for enhancing aquaculture investment in the World Bank Group, around three strategic objectives: (i) Changing mindsets towards aquaculture; (ii) Strengthening collaboration & partnerships; and (iii) Better & more country aquaculture investments. The core of the Aquaculture Digital Roadmap is 10 Action Areas that provide specific actions to support aquaculture promotion and development and progress towards the strategic objectives over the time frame from 2025 to 2030. The presentation provides the background to the Roadmap and strategic direction emerging from the assessments and consultations conducted during the project.

MORPHOLOGICAL CHARACTERISTICS REVEAL PHENOTYPIC PLASTICITY BETWEEN WILD AND CULTURED AFRICAN CATFISH *Clarias gariepinus* (BURCHELL, 1822) FROM SOUTHERN MALAWI

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The culture of *Clarias gariepinus* is getting momentum in Malawi's aquaculture, yet the fish remain uncharacterized. This study used morphometric measurements to determine the variation between cultured and wild African catfish from Southern Malawi. High phenotypic plasticity was observed between cultured and wild African catfish as the two populations were significantly different in all the measured morphological characteristics except for body depth ($p>0.05$). African catfish from Domasi Aquaculture Center were found to be significantly different with all the other studied wild populations (Lake Malawi, Lake Malombe and Shire River) except for Lake Chilwa ($p>0.05$).

The discriminant analysis confirmed that the wild and cultured African catfish are two different population based on the morphological measurements when the discriminant function classified the samples correctly to their groups by 80% and 93% as cultured and wild respectively. The length weight relationship for both wild and cultured African catfish revealed a positive allometric growth with a b-value greater than 3, an indication that fish becomes heavier with increase in length. Further to this, the condition factor was high for cultured stock than their wild counter parts, an indication of excellent nutrition well-being in the culture environment. However, both stocks had a condition factor greater than 1 which indicated stable physiological state. This is attributed to use of commercial feed in aquaculture which supplements the natural food in the pond. The study concludes that there is need to conduct genetic studies to confirm that the fish stocks classified as morphologically different in this study are distinguishable in their genetic make-up.

Table 1. Morphological variation between wild and cultured *C. gariepinus*.

	Wild Population			Cultured Population			
Parameters	**Min**	**Max**	**Mean±SD**	**Min**	**Max**	**Mean±SD**	***P-Value***
Weight (g)	28	805	262.44±169.89	38	458	149.76±115.52	0.002
Standard Length (cm)	15.6	48.5	28.78±6.06	16.5	38	23.52±5.72	<0.001
Total Length (cm)	17.4	54.1	32.57±6.92	18	41.6	26.03±6.49	<0.001
Body depth (cm)	2.6	7.5	4.87±1.05	3	6.6	4.45±1.04	0.078*
Head length (cm)	4.2	12.5	8.11±1.89	4.2	8.7	5.88±1.30	<0.001

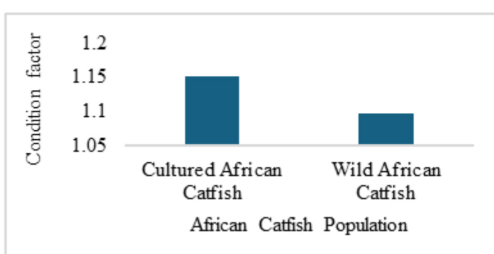

Figure 1. Condition factor of wild and cultured *C. gariepinus*

REDUCING POST-HARVEST LOSSES IN ZAMBIA'S FISHERIES SECTOR: PROFISHBLUE PROJECT

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Post-harvest losses (PHLs) remain a critical challenge in Zambia's fisheries sector, particularly for small-scale fishers and traders operating in remote and rural areas with limited access to cold storage and transportation facilities. It is estimated that approximately 10% to 70% losses are being experienced in certain regions of Zambia, depending on factors such as infrastructure availability, and preservation methods. These losses not only undermine food security but also limit income potential and market access for fish value chain actors. In response to this challenge, the Africa Women Fish Network (Aw-Fishnet) Zambian Chapter, through support from the Southern African Development Community (SADC) and the African Development Bank (AfDB), was awarded a refrigerated truck under the Programme for Improving Fisheries Governance and Blue Economy (PROFISHBLUE) project to pilot a practical solution aimed at mitigating these losses. This intervention aims to enhance cold chain logistics and significantly reduce PHLs during fish transportation from landing sites to markets.

This presentation will explore the effectiveness of the refrigerated truck in reducing spoilage, improving fish quality, and increasing profitability among women and youth fish traders. It will also highlight the broader implications of such innovations on sustainable fisheries development and regional trade. It reinforces the importance of regional cooperation and funding mechanisms like PROFISHBLUE in accelerating sustainable blue economy initiatives in Africa. The study also underscores the importance of targeted investments in infrastructure and logistics for transforming Africa's aquatic food systems.

CLIMATE CHANGE IMPACTS, MITIGATION, AND ADAPTATION IN FISHERIES AND AQUACULTURE

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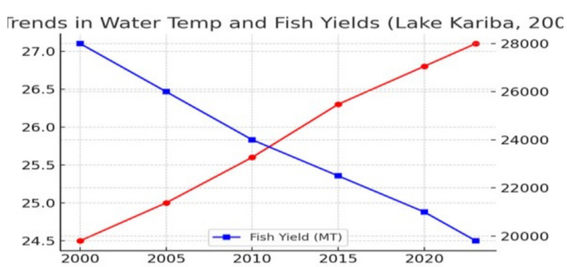
Climate change poses a significant threat to the sustainability of fisheries and aquaculture, particularly in developing regions such as sub-Saharan Africa where livelihoods and food security are closely tied to aquatic resources. Rising temperatures, erratic rainfall patterns, increased frequency of extreme weather events, and ocean acidification are disrupting aquatic ecosystems, altering fish distributions, and reducing productivity. This study highlights the multifaceted impacts of climate change on fisheries and aquaculture, with a focus on the African Great Lakes and inland fisheries systems, using Zambia as a case study. The research utilizes data collected from meteorological trends (1990–2023), fish stock assessments, and aquaculture performance metrics to illustrate how climatic shifts have influenced fish yields and the livelihoods of small-scale fishers. Notably, fish yields from Lake Kariba have declined by an estimated 18% over the last two decades, attributed largely to water temperature increases and prolonged drought periods (Figure 1).

Mitigation strategies explored include improved feed efficiency, adoption of renewable energy in fish processing, and reforestation of buffer zones. Adaptation measures such as species diversification, climate-smart aquaculture technologies and mobile cold storage innovations have shown promise. The study also showcases a successful example from Zambia, where a refrigerated truck—procured under the Programme for Improving Fisheries Governance and Blue Economy (PROFISHBLUE) project for the Africa Women Fish Network (Aw-Fishnet) Zambia Chapter—has significantly reduced post-harvest losses and enhanced climate resilience among youth and women fish traders. In conclusion, the study emphasizes the need for integrated climate-smart policies, investment in climate-resilient infrastructure, and regional collaboration to ensure the future viability of fisheries and aquaculture sectors.



ARTEMIA – ONE OF THE BEST OPTION OF LIVE FEED FOR AQUACULTURE

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The development of shrimp larvae or fish fry is one of the most critical stage in aquaculture production. The poor development of the digestive system and the small size of the mouth from 100 to 400 microns limits the use of inert feeds at these initial stages. Thus, administering live feeds in the early stages of the life cycle is crucial for onset development and production performance.

One of the most popular and widely used types of live feed in aquaculture is the brine shrimp eggs (artemia cysts).

Artemia as a starter feed, in addition to enriching with nutrients, helps the development of locomotor functions in shrimp larvae and fish fry, and thereby master the predatory instinct. This leads to an enhanced growth rate and general condition. Inversely, using dry feed completely eliminates the factor of food objects mobility, and therefore live feed is still irreplaceable in the early stages of the life cycle.

Artemia is also one of the best sources of protein and can be used as a complete starter feed for shrimp larvae and fish fry. Its nutritional profile guarantees excellent survival of fry for shrimp and fish. Furthermore, in addition to protein and nutrients, Artemia contains carotenoids, which increase the brightness of colouration, and especially important aspect in ornamental fish farming, i.e. koi culture.

There are several major large salt lakes in the world with - stable sources of Artemia. A few of these lakes are located in Russia.

The Arsal Company is one of the leading corporations in the extraction and processing of Artemia cysts. The Great Yarovoye Lake is located in one of the cleanest and most environmentally friendly regions of Russia -the Altay Territory. Artemia harvested from the Great Yarovoye lake is unique, has an exceptional bright colour, has a good nutritional profile and is appreciated and sought after by many companies around the world producing fish and shrimp.

Arsal Company has been engaged in harvesting and processing of Artemia cysts since 1996, and provides traceability of each stage of production and its own laboratory. This helps to guarantee a high and stable quality of Artemia cysts.

In October 2024, a scientific consortium «InterAquatex» was created on the footpring of Arsal to unites the efforts of several countries, including the Russian Federation, South Africa and Malaysia. The vision is to reinforce research and development of Artemia as a valuable resource and its effective use in the world of aquaculture.

The presentation will elaborate on current and future plans on Artemia research and collaborations.

Not long ago, a scientific consortium "InterAquatex" was created on the basis of the company, which unites the efforts of several countries - the Russian Federation, South Africa and Malaysia and is aimed at a deeper study of Artemia as a valuable resource and its effective use in the world of aquaculture.

IS AQUACULTURE 'PRO-POOR' IN KENYA'S LAKE VICTORIA?

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Significant investments have been poured into Kenya's cage aquaculture industry on Lake Victoria. Furthermore, its development is encouraged in Kenya's Blue Economy Strategic plan. But considering the extremely high rates of malnutrition and poverty among its lakeshore populations, the aquaculture industry's impact on poverty should be scrutinized. Thus, this study aimed to examine aquaculture's effect on the food security of these littoral communities. The study achieved this by understanding the communities' perception of the industry, its socio-economic effects on livelihoods and the local economy, and to what extent farmed tilapia contributed directly to local diets. The methods used qualitative and quantitative research methods: interviews, focus groups, a household questionnaire, and dietary intake data.

This study found that overall, tilapia cage farming was welcomed into the community as complimentary to fishing. Locals viewed aquaculture as a 'modern' version of fishing, rather than a distinct or competing industry. In contrast to the 'traditional' and deteriorating fishing industry, which was tarnished by its risky and dangerous reputation, tilapia farming employment that provided a dependable income was respected and coveted. Because of employment opportunities, local residents were positive about and in favour of industry growth. Furthermore, locals believed that aquaculture would support sustainable fisheries: employment generated by aquaculture could continue to convert fishers into fish farm employees, reducing pressure on fisheries and improving catch-per-unit-effort for remaining fishers. Indeed, the emergent tilapia cage culture industry provided ample employment opportunities, with financial knock-on benefits to local economies.

Direct nutrition gains from consumption of farmed tilapia were limited. While most people still sourced and preferred to source tilapia from fisheries, cultured fish were consumed with increasingly frequency as a result of emergent local aquaculture. Yet, it was only affordable by wealthier households, and worse-off households ate farmed fish significantly less frequently. Farmed tilapia largely remains a luxury item. Continued development of aquaculture has the opportunity to practice inclusive business models. For example, the strategic production of smaller tilapia could be a 'pro-poor' and inclusive business model that increases tilapia accessibility. Additionally, avoiding the use of omena/dagaa (*Rastrineobola argentea*) in aquafeeds would be socially responsible: omena is a critical source of nutrition for lakeshore communities with disproportionate importance in worse-off diets, and increased demand from aquaculture could drive up prices and reduce its accessibility for the poor.

Thus, aquaculture can offer benefits as well as consequences, changeable with the characteristics of the businesses and adaptations of the community. Answering the question "Is aquaculture pro-poor?" in Kenya's Lake Victoria has required embracing the complexity of the whole food system and pathways to impact. Multidisciplinary approaches have been critical. Similar investigations should be performed in Uganda and Tanzania: understanding contextual differences is essential to adequately and appropriately inform international policies regarding the lake and its emergent aquaculture industry.

SMALL FARMED TILAPIA POWDER TO ALLEVIATE CHILDHOOD STUNTING IN RWANDA

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Rwandan public health is challenged with malnutrition, which causes childhood stunting among other public health challenges. As of 2021, approximately 32% of Rwandan children were stunted. As of 2021, only 30% of reproductive-aged Rwandan women met the minimum dietary diversity required for adequate nutrition. Child nutrition was also largely inadequate, with only 17% of children (6-23 months) meeting the minimum acceptable dietary diversity and meal frequency, eating less than 3 different food groups over only two meals on average each day. Even when supplementary foods are introduced, they are insufficient: over 60% of weaning children (aged 6 to 23 months) fail to meet the recommended daily intakes for iron, calcium, and zinc due to the low availability (both nutrient density and bioavailability) of these micronutrients in their supplementary food.

Interventions involving micronutrient powder (MNP) for inclusion in home-cooked foods have shown promising results. MNP have been distributed to all children (6-23 months) through Rwandan health centres and community health workers. Haemoglobin levels in anaemic children increased due to this intervention. After successfully trialled by UNICEF and the University of British Columbia, the Rwandan government implemented the programme across Uganda in 2021. Yet, this programme has experienced difficulties scaling up: only 6% of children in participating districts were consuming MNP. The main challenges were inadequate supply of MNP and consumer perceptions that it was only for 'sick' children.

By addressing these barriers to Rwanda's current MNP programme, this project aims to alleviate malnutrition and childhood stunting through small tilapia powder (STP) consumption. Previous projects have successfully trialled MNP, but their scaling was limited due to international supply chain issues. This is the primary barrier that this project will address, by locally producing a whole-food based MNP from locally-farmed small tilapia. Because animal source food consumption is lacking among lower-income demographics in Rwanda, inclusion of STP could increase dietary diversity by an entire food group. Furthermore, because small tilapia are micronutrient dense, the inclusion of STP in diets will support adequate intake of a variety of nutrients. This builds on previous interventions which targeted anaemia only. Additionally, previous MNP intake was limited at the household level because mothers' perception that the MNP was a medicine for sick children only. This project addresses this issue by supplying a whole food based supplement, based on a food item (fish) that is already known and accepted by the community.

EARLY NUTRITIONAL STRATEGIES TO IMPROVE LARVAL REARING IN SEABREAM (*Sparus aurata*)

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Larval rearing protocols for gilthead seabream are already well established and current efforts focus on fine-tuning these protocols, particularly on this important stage or during stressful events that can happen during the daily routines.

The early nutritional programming of fish larvae plays a key role in shaping robustness, growth potential, and overall performance throughout the production cycle. This study aimed to evaluate the impact of distinct early feeding strategies — assess the effect of novel dietary formulations adapted by micro extrusion technology and evaluate the impact on the inclusion of natural functional extracts — on the performance and stress response of gilthead seabream (*Sparus aurata*).

Two independent feeding trials were conducted: 1) *S. aurata* larvae were fed from 43 to 74 days after hatching (DAH) with 4 different diets (A – Control commercial diet; B – adaptation of a commercial diet with a different extrusion technology; C - adaptation of a commercial diet to a different extrusion technology and replacement of crustacean meal; D - adaptation of a commercial diet to a different extrusion technology and replacement of protein hydrolysates). At the end of the trial, fish were subjected to a stress test involving air exposure; 2) *S. aurata*, post-larvae (80 DAH) were fed for one week with diets enriched with increasing concentrations of grapeseed or *Ulva* spp. extracts, followed by a stress test involving air exposure and a *Photobacterium damselae* subsp. *piscicida* challenge.

Results from the first trial revealed no deleterious effects of the different extrusion methodologies or ingredient replacements on survival, growth or stress resistance of seabream larvae, paving the way for the use of different technologies for microdiets manufacture. In the second trial, functional diets showed limited effects on stress-related gene expression under baseline conditions, but fish fed low inclusion levels of *Ulva* extract (ULOW) exhibited significantly elevated antioxidant markers (e.g., *gpx1*, *gpx4*) after stress, suggesting a protective effect against stressful situations. Additionally, these diets appeared to offer some protection during acute stress, although not during bacterial infection.

These findings reinforce the relevance of tailored early feeding strategies, from inert diet timing to functional supplementation, as promising tools to promote fish robustness and performance. Optimisation of diet formulation and timing is essential to achieve consistent and sustainable results in marine larviculture.

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EFFECTS OF WATER HYACINTH-BASED *(Eichhornia crassipes)* VERMICOMPOST TEA (AQUEOUS EXTRACT) SUPPLEMENT ON GROWTH PERFORMANCE OF LETTUCE UNDER A NON-CIRCULATING HYDROPONICS SYSTEM

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Water hyacinth is a destructive weed found in most water bodies across Africa, and mitigation measures have been implemented to control its spread. Water hyacinth is a nutrient-rich macrophyte that depends on the water body. It can be used as animal fodder and vermicomposting material. The study aimed to investigate the potential use of water hyacinth-based vermicompost tea material in a non-circulating hydroponics system for improved lettuce production and management of water hyacinth. A systematic random sampling design was applied with 33 plants per unit. Three dilutions, 30%, 40% and 60%, were used to compare the effect of various dilutions of water hyacinth-based vermicompost tea on the growth performance of lettuce in non-circulating hydroponic systems. Growth was analysed using leaf area, shoot length, root-shoot ratio, growth rate and moisture content analysis. Ash and digesting methods were used to determine the effect of various dilutions of water hyacinth-based vermicompost tea on the uptake and concentration of selected nutrients and heavy metals quantity in lettuce and vermicompost. Lettuce dosed with hydroponics nutrient solution was significantly different at ($P<0.05$) from lettuce supplied with water hyacinth-based vermicompost extract dosed at 30%, 40% and 60%. The lettuce plants with hydroponics nutrient solution had a higher growth rate, shoot length and moisture content, large leaf area and a small root-shoot ratio. Lettuce dosed with water hyacinth-based vermicompost tea were significantly short in nutrient content in their solutions, while the ones with synthetic solutions had enough nutrient supply. Lettuce dosed with water hyacinth-based vermicompost tea had nutrient and heavy metal concentrations within the permissible limit, except that treatments dosed at 30% and 40% were significantly different in lead (Pb) and zinc (Zn) values. Therefore, a non-circulating hydroponics system can be used for lettuce production to conserve water, with WHBCVT used as the nutrient supplement.

THE FIRST STUDY ON THE EFFECT OF DIETARY BLACK SOLDIER FLY (*Hermetia illucens*) PRE-PUPAE MEAL ON FLATHEAD GREY MULLET (*Mugil cephalus*) GROWTH, HEALTH AND IMMUNE RESPONSE

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Developing sustainable aquafeeds and diversifying farmed fish species, with focus on that with a low dependency on marine-derived ingredients, is crucial for the modern aquaculture. In the present study, for the first time, low-fish meal diets, in which black soldier fly (*Hermetia illucens*) meal was used to partially replace conventional ingredients, were formulated to assess the effect on growth, gut health and immune status of flathead grey mullet (*Mugil cephalus*).

Four, iso-proteic, iso-lipidic and iso-energetic diets were formulated to replace the conventional protein sources of a control diet (H0) with 10, 15 and 20 % black soldier fly (*Hermetia illucens*) meal (H10, H15 and H20, respectively). For the feeding trial, 360 juvenile grey mullets (weight = 40.2±0.5 g), obtained by the International Marine Center (IMC, Oristano, IT), were transferred to the Institute of Marine Biological Resources and Biotechnologies, National Research Council (IRBIM-CNR, Messina, IT). After acclimatation, fish were randomly divided in 12 experimental tanks, connected to an open recirculating system located on the Sicilian coast of the Strait of Messina (Temperature, 22,05±9,12 °C; O_2, 66.5±8.1 mg L^{-1}; Salinity=, 39.07±0.41 PSU; pH, 8.62±0.42). Fish were assigned to the four dietary treatments, in triplicate and fed the experimental diets (1-3% body weight, according to the water temperature) for 138 days. At the end of the experiment, after euthanasia (MS-222 500 mg L^{-1}), fish were individually weighted and gut, liver and spleen were sampled and processed for histological and immunohistochemical analyses.

At the end of the experiment, fish fed H15 and H20 diets showed a significantly lower final weight compared to those fed H0 and H10 diets. Moreover, fish fed diet H20 showed a significantly lower Fulton condition factor compared to the other groups. Gut histology was marginally affected by the experimental diets (fig.1 a); however, a significant increase in villi thickness and mucous cells abundance was evidenced in group H15. No alterations in liver and spleen histology were observed within the experimental groups. Immunohistochemical analyses revealed an increase in TNFα+ cells in anterior intestine (fig. 1b) of fish fed H10 diet.

According to the results obtained in the present study, the tolerance of *M. cephalus* to dietary *H. illucens* meal is lower compared to other, strictly carnivorous farmed fish species. However, replacing conventional protein sources with 10% *H. illucens* meal can play a role in improving fish gut health as indicated by the significant increase in TNF+ cells in intestine of fish from H10 group, suggesting a role of this ingredient in improving fish immune defenses, without affecting fish zootechnical performances.

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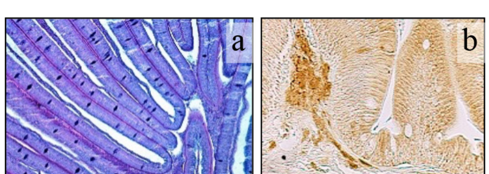

Figure 1. a) Representative histological micrograph of *M. cephalus* intestine; b) TNF+ cells in the anterior in a fish from H10 group.

BUILDING AQUATIC ANIMAL HEALTH GOVERNANCE IN LAKE VICTORIA THROUGH THE FAO PMP/AB FRAMEWORK: THE TRUEFISH REGIONAL MODEL

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The “True Fish Farming Story in the Lake Victoria Basin” (TRUEFISH) project, funded by the European Union under the 11th European Development Fund and implemented by the Food and Agriculture Organization of the United Nations (FAO), has enabled the establishment of a coherent governance framework for Aquatic Animal Health (AAH) in East Africa. The intervention followed the methodological guidance of the FAO Progressive Management Pathway for Improving Aquaculture Biosecurity (PMP/AB), ensuring a gradual and structured approach from assessment to implementation.

The process commenced with national performance evaluations of AAH systems in five countries (Burundi, Kenya, Uganda, Rwanda and Tanzania). These assessments, conducted with the active engagement of specifically designated by concerned authorities, National Focal Points (NFPs), identified major capacity gaps, including the absence of coordinated surveillance programmes, weak diagnostic infrastructure, lack of enforceable national regulatory frameworks, limited emergency response systems, and insufficient cross-sectoral coordination mechanisms. Based on these findings, and through regional consultation and technical facilitation, a Regional AAH Techncial Working Group was established under the coordination of the Lake Victoria Fisheries Organization (LVFO). This group led the development of a five-year roadmap and the drafting of a Regional Aquatic Organisms Health Strategy (RAOHS), which was formally endorsed by the LVFO FASCoM in May 2024 and signed by the ministers of fisheries of the participating countries.

Following the regional endorsement, TRUEFISH provided technical and operational support to strengthen national strategies for aquatic animal health management. Each country developed and validated its national surveillance and contingency plans for aquaculture disease control. These efforts were accompanied by the delivery of training programmes targeting both public sector officers and commercial aquaculture operators, with more than 75 professionals trained in risk analysis, surveillance, and emergency response. Institutional partnerships are being established under TRUEFISH with leading national research and academic institutions—including Makerere University, the National Fisheries Resources Research Institute (NaFIRRI), the Kenya Marine and Fisheries Research Institute (KMFRI), the Tanzania Fisheries Research Institute (TAFIRI), and the Nelson Mandela African Institution of Science and Technology (NM-AIST)—to support field deployment of monitoring activities, procurement of diagnostic equipment and performance of laboratory analysis (histopathology, PCR, etc.). These interventions are directly embedded into national strategies under development in the five countries (finalised and validated for Rwanda) and aligned with country-level regulatory frameworks.

Throughout the entire process, national authorities were actively involved in planning, validation, and implementation, ensuring institutional ownership and long-term sustainability of the biosecurity systems established. The experience also integrates regional learning with global good practices, including through an international study tour to the Philippines, organized in close collaboration with the Bureau of Fisheries and Aquatic Resources (BFAR) and the Southeast Asian Fisheries Development Center (SEAFDEC). Scheduled for first week of June 2025, this mission will foster South–South technical exchange on aquatic health governance, surveillance systems, and regulatory frameworks. The TRUEFISH AAH component ultimately demonstrates the applicability of the PMP/AB approach in strengthening regional coordination, reinforcing national capacities, and laying the foundation for science-based, sustainable aquaculture biosecurity systems in transboundary water ecosystems.

IMPROVING AQUATIC BIOSECURITY MANAGEMENT THROUGH A RISK-BASED, COLLABORATIVE AND PROGRESSIVE APPROACHES TO SAFEGUARD HUMAN HEALTH, THE ENVIRONMENT AND NATIONAL ECONOMIES IN THE FACE OF A RAPIDLY CHANGING WORLD

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Recognized as the fastest growing food-producing sector in the world, and rapidly developing in Africa, disease is a major limiting factor for successful aquaculture production, with lasting effects on socio-economic development in many countries. Country-level impacts of a significant disease can be estimated indirectly through the level of income, production losses, employment, international trade, investments and consumer confidence.

Aquatic disease situation is changing rapidly and very difficult to predict due to the current period of accelerated change in the international trading environment– affected by globalization, increasing aquaculture production, microbial adaptation and climate change.

The Progressive Management Pathway for Aquaculture Biosecurity (PMP/AB), an initiative developed by the FAO and its partners, uses risk-based approaches, public–private sector partnerships and progressive implementation. The PMP/AB is expected to result in the sustainable (i) reduction of burden of aquatic diseases; (ii) improvement of aquatic health and welfare at farm, national and regional levels; (iii) minimization of global spread of diseases; (iv) optimization of socioeconomic benefits from aquaculture; (v) attraction of investment opportunities into aquaculture; and (vi) achievement of One Health goals.

INNOVATING AFRICAN AQUACULTURE: FROM RESEARCH TO SUSTAINABLE IMPACT IN AQUATIC FOOD SYSTEMS

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Housed at the Global Center for Aquatic Health and Food Security (GCAHFS: www.gcahfs.msstate.edu) at Mississippi State University and funded by the U.S. Agency for International Development (USAID), the Feed the Future Innovation Lab for Fish worked from 2018–2025 to reduce poverty and improve nutrition, food security, and livelihoods in partner countries through the research and development of innovative solutions in aquaculture, fisheries, and aquatic-foods-based nutrition. As one of the Feed the Future Innovation Labs, it leveraged the expertise of U.S. universities and research institutions across Africa and Asia to tackle critical challenges in agriculture and food systems.

Over the course of the program, the Fish Innovation Lab supported 30 research activities, 19 of which were in Africa: Ghana (1), Kenya (5), Nigeria (7), and Zambia (6). It enabled and leveraged collaborations to conduct critical research that led to the development of over 50 innovations across aquaculture and fisheries sectors, with more than 2,000 individuals adopting these technologies. In Africa, where the aquaculture sector is rapidly growing, 28 innovations were developed to sustainably enhance productivity. These innovations included technologies to strengthen biosecurity and prevent diseases, improve fish-based market conditions and access, identify alternatives for fish feed, adapt integrated aquaculture systems to local conditions, and address farm inefficiencies among small-scale fish farmers.

Recognizing the importance of sustainability beyond the program's duration, the Fish Innovation Lab emphasized scaling innovations within the local and regional food system. Researchers were encouraged to articulate a clear pathway to scale, identifying enabling conditions, end users, institutional partners, and additional funding mechanisms. As a result, multiple innovations advanced towards broader adoption through a range of scaling pathways. These included the integration of data and resources into open-access online platforms, stakeholder convenings to support dissemination of research findings, and collaboration with local partners such as extension services to conduct end-user-informed research on vaccines. Other approaches included establishing stakeholder networks, including a veterinary network, and engaging in policy discussions to introduce biosecurity practices into national frameworks. Together, these actions demonstrate that scaling innovations is an ongoing, systems-driven process essential for sustaining the impact of the research.

This presentation traces the journey from research to real-word impact, highlighting not only the technical advances made by the Fish Innovation Lab's research, but also the strategies used to support uptake and scale. As the sector continues to grow and evolve in Africa, this presentation is an opportunity to engage researchers, implementers, donors, and private-sector actors to collaborate in sustaining and expanding these innovations, ensuring that a sustainable aquaculture sector remains central in ensuring food security for growing populations in Africa.

ADVANCING INNOVATION FOR AQUACULTURE ON THE RISE: THE GLOBAL CENTER FOR AQUATIC HEALTH AND FOOD SECURITY

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Established in 2013, the Global Center for Aquatic Health and Food Security (GCAHFS) at Mississippi State University aims to reduce world hunger through research that supports sustainable aquaculture and ecological health of aquatic resources. With more than 50 partners in 12 countries and a portfolio of over $40 million since 2013, GCAHFS has demonstrated expertise in addressing the health of aquatic environments by improving the impact of these important ecosystems on the quality of life of humans, increasing food production and security, implementing aquatic animal disease mitigation strategies, supporting aquaculture technology development and adoption, and promoting sustainable aquatic resource management.

GCAHFS specifically advanced innovation in the rapidly growing African aquaculture sector through the Feed the Future Innovation Lab for Fish, funded by the U.S. Agency for International Development (USAID). The Fish Innovation Lab worked from 2018–2025 to reduce poverty and improve nutrition, food security, and livelihoods in partner countries by supporting research on sustainable aquatic food systems. It was one of the Feed the Future Innovation Labs which leveraged the expertise of U.S. universities and developing country research institutions to tackle some of the world's greatest challenges in agriculture and food security.

Over the course of the program, the Fish Innovation Lab supported 30 research activities, 19 of which were in Africa: Ghana (1), Kenya (5), Nigeria (7), and Zambia (6). The lab also supported work in Bangladesh, Cambodia, and a four-country study across Madagascar, the Pacific Islands, Peru, and the Philippines. Fish Innovation Lab activities in Africa addressed major issues in aquaculture and fisheries. In Nigeria, teams investigated different ways to improve aquaculture production and provide better quality fish products to consumers as well as how to assess fish supply from inland water bodies and potential impacts from climate change. In Kenya and Ghana, teams worked to improve the sustainability of local fisheries and provide nutrition training and information to promote consumption of aquatic foods for better nutrition amongst fishers, mothers, and children. They also analyzed fish health and antimicrobial resistance in aquaculture and started developing climate-smart solutions to integrate agriculture and aquaculture through aquaponic systems. Activities in Zambia captured a wide range of work, from fish vaccine development to reduce aquaculture losses to assessing population ecology and current distribution of introduced invasive crayfish. Additional work in Zambia developed a dried fish powder along with recipes for enhanced nutrition, particularly benefiting mothers and infants in vulnerable households.

To learn more about the activities of the Global Center for Aquatic Health and Food Security, visit our website at www.gcahfs.msstate.edu.

CROSS-SCALE ANALYSIS OF HOUSEHOLD AND ORGANIZATIONAL ADAPTIVE CAPACITY: INSIGHTS FROM WOMEN'S FISHERIES ORGANIZATIONS IN UGANDA

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The impacts of anthropogenic stressors like climate change on fishery-dependent communities are well documented globally and understanding factors that contribute to the adaptive capacity of fishing households is an active area of research. Scholars have recognized the important role of social organization in shaping adaptive capacity at various scales, particularly for marginalized groups (e.g., women) who lack access to critical resources. However, little research has been conducted to understand how adaptive capacity of community-based organizations may mediate adaptive capacity for its members and their households. In this study, we use the case of women's fisheries organizations in Uganda to examine whether and how organizational adaptive capacity (variety, learning capacity, room for autonomous change, leadership, resources, and fair governance; Gupta et al., 2010) mediates household adaptive capacity (flexibility, assets, organization, learning, socio-cognitive constructs, and agency; Cinner & Barnes, 2019) for women that are members of different women's fisheries organizations. We apply food systems thinking to consider the role of organizational adaptive capacity in shaping adaptive capacity for the households of women engaged in production (e.g. renting boats and or engines), provisioning (e.g., processing, trade), and consumption (e.g. keeping fish for household consumption) activities.

Across Buikwe, Jinja, and Mukono districts, we conduct interviews with leaders of women's fisheries organizations (n=10) to understand governance (i.e. rules and power dynamics) and organizational adaptive capacity, and surveys with members of the same organizations (n=150; 15 per group) to measure household adaptive capacity. The same survey instrument is also deployed with individual fisheries actors at landing sites (n=80 individuals; n=230 total surveys) to compare household adaptive capacity between those in groups and those not in groups. We use statistical tests (ANOVA, Kruskal-Wallis) to compare household adaptive capacity between groups and qualitative comparative analysis (Ragin, 1998) to gain further insight into differences in governance structure that contribute to organizational adaptive capacity. Finally, we apply social-ecological resilience theory and analyze adaptive capacity across scales using an inductive approach to make links between organizational adaptive capacity and household adaptive capacity. Our findings can inform gender-sensitive policies and interventions aimed at improving governance of women's fisheries organizations.

NUTRIMO PROJECT: DEVELOPMENT OF ARTISANAL TILAPIA FEEDS TO ENHANCE NUTRITION IN COMMUNITY-BASED AQUACULTURE IN MOZAMBIQUE

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Although aquaculture has the potential to become a key source of animal protein in Mozambique, its expansion is limited by restricted access to cost-effective, high-quality feeds. This study formulated an artisanal tilapia diet using nine local ingredients from Balama and Namuno (Cabo Delgado, Mozambique), including cassava roots and leaves, moringa, maize, pearl millet, peanuts, and three local beans (bóer, jugo, nhemba). Nutritional profiles were assessed, and formulations tested in zootechnical trials.

An artisanal diet using locally sourced ingredients was tested against a commercial-like feed in controlled laboratory trials in Portugal, assessing SGR, FCR, VSI, body condition, whole-body composition, nutrient retention and balance, and digestive efficiency in juvenile *Oreochromis niloticus* (~10 g). A 60-day outdoor happa trial under African conditions validated the artisanal formulation (Figure 1), comparing artisanal (ART) and locally available commercial (COM) feeds in juvenile *O. niloticus* (~7.5 g) and *Oreochromis mossambicus* (~2.8 g).

In laboratory trials, *O. niloticus* fed the artisanal diet showed significantly reduced growth but similar intake, with improved nutrient retention and stable body composition. Field validation under African conditions revealed comparable performance between artisanal and commercial diets for *O. niloticus*, likely aided by natural protein inputs (e.g., insect larvae) that offset the diet's moderate protein level (< 30%). In contrast, *O. mossambicus* showed significantly lower SGR, possibly due to genetic factors or higher protein requirements in smaller juveniles. Further production-scale studies are needed to validate these results.

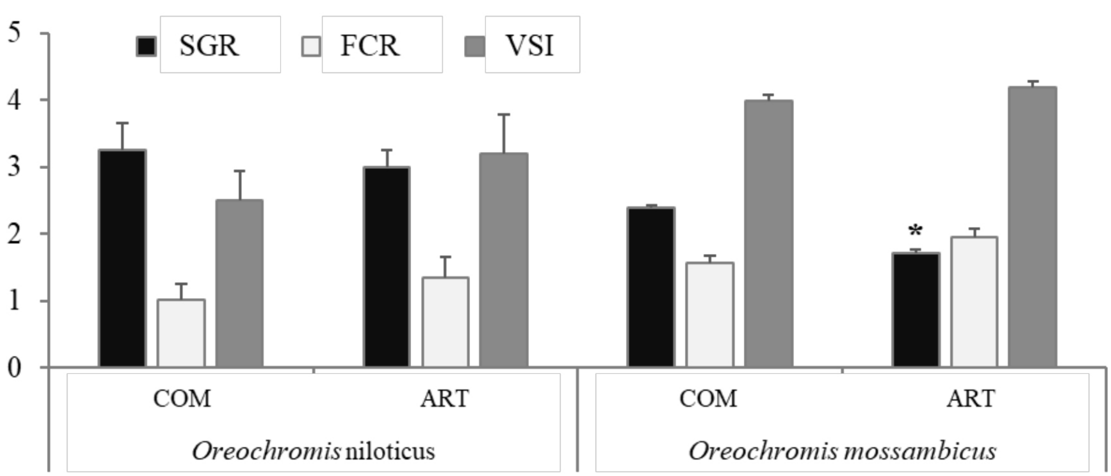

Figure 1. Specific growth rate (SGR), feed conversion ratio (FCR), and viscerosomatic index (VSI) of *Oreochromis niloticus* and *Oreochromis mossambicus* fed artisanal (ART) and commercial (COM) diets under field conditions in Cabo Delgado, Mozambique.

DIGITAL TECHNOLOGIES CAN PROVIDE SOLUTIONS TO THE AQUACULTURE SECTOR IN A WAY THAT COULD NOT BE DONE FOR. HOW BUNA AFRICA, AN ONLINE AQUACULTURE PLATFORM DEVELOPED BY RHODES UNIVERSITY (SOUTH AFRICA) IS REIMAGINING OLD PROBLEMS

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Aquaculture in Africa is shifting away from subsistence type farming that were promoted by development partners in the 70's and 80's to one that is now focused on production and profit. With this shift, farmers are now increasingly using the Internet of Things (IoTs) to access information and services in real time. This move towards digitalisation is being facilitated by increasing internet coverage and smart phones becoming increasingly affordable.

Governments in Africa are also increasingly looking at digitalisation to solve their data problem. Without access to reliable and regular production data from farmers, the ability for governments to develop informed policies and to manage and develop the sector is diminished.

Buna Africa (www.bunaafrica.org), is an online aquaculture platform that has been developed by the Department of Ichthyology and Fisheries Science of Rhodes University (South Africa). Buna provides a digital pathway for farmers to submit their production data to government. Buna recognises that for farmers to submit production data, the platform must also give back and address their needs. Buna therefore provides fish farmers with a range of technical support and services, in real time.

Some of the functionalities in Buna include, technical manuals and YouTube videos, the weather in real time linked to the farmers location, a directory of service providers (such as seed and feed producers), a built-in messaging system in real time to connect farmers, a virtual marketplace to connect farmers to fish traders, a bookkeeping facility and fish health services.

All data that farmers submit is also made available to them, in a manner that they can use to manage and develop their facility. Privacy settings in the code design of Buna ensures that no farmer can see other farmers data.

As digital technologies develop, such as Artificial Intelligence, the roles of digital tools such as Buna, will increasingly be used by the sector. The aquaculture value chain in Africa should take advantage of this technology and incorporate it into their operations.

WHERE ARE MY FARM BOOKS?

Roz

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By diligently maintaining records, a farmer can build a strong foundation for investor preparedness, demonstrate the viability and potential of their business, and ultimately attract the capital needed for growth and expansion. This session will aim to create awareness among farmers on pointers to which their business should be structured, managed, and documented in a way that makes it attractive and understandable to potential investors. Participants would learn about transforming a farming operation from a primarily production-focused activity into a viable and scalable business opportunity.

THE EFFECT OF *Lysinibacillus fusiformis* DIETARY SUPPLEMENTATION ON THE GUT MICROBIOME OF JUVENILE NILE TILAPIA *Oreochromis niloticus*

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Probiotics play a crucial role in modulating the gut microbiome of farmed fish, potentially improving health and growth performance. This study investigated the effects of dietary supplementation with *Lysinibacillus fusiformis*, a Ugandan strain - LFUG on the gut microbiome of juvenile Nile tilapia (*Oreochromis niloticus*) under controlled conditions.

Two concentrations (T1: $1x10^6$ CFU/g; T2: $1x10^8$ CFU/g) and the control (0 CFU/g) were used for 60 days, followed by collecting hindgut tissues from six fish per treatment. Genomic DNA was extracted (QIAamp Fast DNA stool mini kit - Qiagen, Germany) and subjected to full-length 16S rRNA sequencing using a PromethION device. Alpha and beta diversity analyses were conducted, and community differences were assessed.

Despite increasing the bacterial species richness of the microbiome (Fig. 1), LFUG dietary supplementation did not significantly affect both the alpha and beta diversities compared to the control. However, the differentially abundant taxa were detected in the control and LFUGT2 but not LFUGT1 (Table 1). Moreover, LFUGT2 differentially abundant taxa were beneficial bacteria (*Romboutsia* sp., *Allorhizobium–Neorhizobium–Pararhizobium–Rhizobium* sp. and *Vulcaniibacterium thermophilum)* compared to the control (*Cetobacterium* sp). (Table 1). *Cetobacterium* sp. is a common bacterium in freshwater fish species including Nile tilapia, whose reduction after probiotic feeding is indicative of microbiome modulation towards proliferation of beneficial taxa, which enhance gut health and overall host wellbeing.

In conclusion, *Lysinibacillus fusiformis* LFUGT dietary supplementation influenced gut bacterial composition but did not significantly impact overall microbial diversity. Proliferation and dominance by beneficial bacteria was enhanced, which potentially improved fish health while reducing opportunistic pathogens.

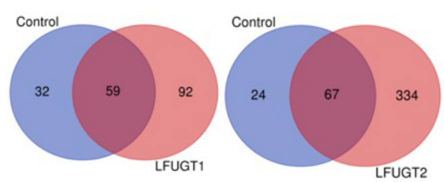

Figure 1: Species counts in the different treatments after 60 days of feeding

Table 1: The significantly differential taxa of the different treatments when compared with the control

Treatment	Differentially abundant taxa
Control	*Cetobacetrium* sp.
LFUGT1	-
LFUGT2	*Romboutsia* sp., *Allorhizobium−Neorhizobium−Pararhizobium−Rhizobium* sp. and *Vulcaniibacterium thermophilum*

EMPOWERING A NEW GENERATION OF AQUACULTURE PROFESSIONALS: REFLECTIONS ON EDUCATION, CURRICULUM REFORMS, AND SUSTAINABLE DEVELOPMENT IN UGANDA

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Uganda faces an annual fish deficit of over 500,000 tonnes, despite strong government efforts such as the National Development Plan (NDPIII), which aimed to add 300,000 tonnes by 2025 through aquaculture expansion. Although production rose from 1,000 tonnes in the early 2000s to 101,000 tonnes in 2022 (FAO, 2024; Musinguzi et al., 2019), the NDPIII target remains unmet, and production has since stagnated. Key barriers included poor-quality seed, limited access to affordable feeds, weak private investment, an overreliance on imported technologies, and severe fish health challenges. Moreover, hatcheries experience up to 100% mortality rates (Kasozi et al., 2024). These are exacerbated by over 3,000 cages on Lake Victoria with limited biosecurity. Sustainable solutions require strengthening fish health systems and rethinking aquaculture education and training to prepare competent professionals.

Through a **VLIR-UOS-**funded International Masters in Aquaculture (IMAQUA) at Ghent University, I gained competencies which included fish health management, focusing on sustainable, non-antibiotic solutions such as probiotics and bacteriophages. I trained in international laboratories at Ghent University - Belgium, Nitte University - India, and SLU – Sweden, acquiring skills now applied locally for diagnostics, disease outbreak preparedness, and microbial solutions for sustainable aquaculture intensification. Upon return, I joined Busitema University, where I teach and engage in research and outreach. I spearheaded Uganda's first MSc in Sustainable Aquaculture to address critical curriculum gaps in graduate programs.

Improving Uganda's aquaculture curricula requires deliberate capacity building as higher education correlates with the adoption of advanced systems (Byabasaija et al., 2024), integrating experiential learning (Strong et al., 2023), and boosting technical knowledge transfer (Kasozi et al., 2024). Thus, aquaculture education must integrate Education for Sustainability (EfS) (Ssozi, 2012), hands-on training (Rubinato et al., 2023), and gender and youth empowerment, including entrepreneurship and policy engagement (Byabasaija et al., 2024). Strengthening exchange programs and public-private partnerships will further align graduates with Uganda's aquaculture needs. My PhD work, focusing on novel indigenous probiotics and phage-based biocontrol agents against Nile tilapia pathogens, has led to patentable innovations (Rwezawula et al., 2025) and partnerships for field-based validation and commercialization applications, feeding into Uganda's fish health infrastructure.

Therefore, stakeholder engagement through public-private partnerships (Aanyu et al., 2020) and zonal innovation platforms (Kasozi et al., 2024), alongside exchange programs with countries like India and China (Kasozi et al., 2017), will support continuous learning. The transformation of aquaculture education must be holistic, collaborative, and future-focused, creating professionals who lead sustainably and locally. My education has been transformative, thus, with the right reforms, it can be for many others, too.

SOOTHING FISH: EXPLORING PHYSICAL CONTACT FOR STRESS REDUCTION IN FARMED FISH

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Fish welfare is gaining more attention in both research and public awareness, reflecting a growing recognition of its ethical and economic importance. Fish exhibit a range of behaviours and physiological responses that suggest their capacity to experience pain and distress when exposed to deleterious stimuli. In aquaculture, maintaining fish health and welfare is essential for maximizing productivity and minimizing disease outbreaks. This study investigated physical contact as a potential method for reducing stress in *Sparus aurata* (gilthead seabream) and *Diplodus sargus* (white seabream). Two treatments were tested: one using an apparatus made of plastic rods and silicone bristles to provide physical contact and a control setup with rods but without the silicone bristles. The experiment lasted 21 days, with fish housed in groups of four per tank, each treatment with six replicates. Behavioural assessments were conducted through daily 30-minute video recordings, quantifying apparatus crossing, display, and aggressive interactions. Additionally, half of the fish underwent a stress test, where cortisol levels were measured to evaluate metabolic stress responses. The results highlighted species-specific behavioural and physiological responses to physical stimulation. While *S. aurata* mainly showed behavioural differences without significant physiological changes, *D. sargus* had the opposite pattern, with lower cortisol levels in the bristle treatment but no behavioural differences. These findings suggest that physical stimulation through bristles may have potential for aquaculture application although effects depend on the species, warranting further investigation into the mechanisms underlying these responses.

SCHOOL FARMING: GROWING MINDS AND FOOD THROUGH AQUAPONICS

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The role of aquaculture in ensuring the future supply of fish is undeniable. Aquaponics, a sustainable integration of aquaculture and hydroponics (soilless plant cultivation), creates a closed-loop system where nutrient-rich water from fish waste fertilizes plants, while the plants, in turn, purify the water for the fish. This symbiotic ecosystem exemplifies efficient water use and the principles of the circular economy. School Farming is an educational project launched in 2022 in Lisbon, Portugal, designed to inspire children's interest in nature through hands-on learning. The project involves building an aquaponic system within a school, consisting of a fish tank, a plant-growing bed, and filtration and pumping equipment. Students actively participate in growing various vegetables, such as lettuce, basil, and peri-peri, with plant selection tailored to different school levels. This interdisciplinary program offers practical learning opportunities across multiple subjects, including biology, physics, chemistry, mathematics, and economics, among others. While School Farming serve as valuable learning tools in developed countries, its application in developing regions, where food insecurity is a pressing issue, could have a profound impact. By equipping children with practical knowledge and skills, school farming not only encourages small-scale replication at home but also fosters entrepreneurial thinking, helping to combat poverty and strengthen food resilience.

CULTIVATING THE FUTURE: HOW LAB-GROWN FISH FILLETS COULD TRANSFORM AQUACULTURE DEMAND

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Aquaculture is expanding faster than any other animal food production industry but faces significant challenges, including environmental concerns such as eutrophication, and reliance on wild fish for feed production. Moreover, there is a growing consumer shift towards alternatives to conventional animal-sourced foods that involve minimal or no use of animals. Cultured fish fillets, produced through cellular agriculture, present a promising alternative that could address these challenges and influence aquaculture demand. The project CLEANFISH investigates the potential impact of introducing cultured fish fillets on the access to food, consumer acceptance and environmental sustainability within the seafood industry. As concerns over overfishing, habitat destruction, and food security intensify, cultured fillets offer a viable option to reduce reliance on traditional aquaculture. While initial consumer hesitancy and high production costs pose challenges, advancements in biotechnology and economies of scale may facilitate broader adoption. By applying Life Cycle Assessment (LCA), a comprehensive methodology that evaluates the environmental impacts of a product throughout its entire life cycle, to both recirculatory aquaculture systems (RAS) and cultured fish production, key environmental impacts and areas for improvement can be identified. This analysis aids in understanding how cultured fish could complement or compete with aquaculture, potentially leading to more sustainable seafood production systems and reshaping global seafood markets.

EFFECTS OF STOCKING DENSITY OF NILE TILAPIA *O. Niloticus* AND LETTUCE *L. Sativa* ON THE ECONOMIC VIABILITY OF AN AQUAPONICS SYSTEM IN KENYA

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This study determined the effects of stocking density of *Oreochromis niloticus* on the economic benefits in a small-scale aquaponics system. Three larval stocking densities (150 fish m^{-3}, 300 fish m^{-3} and 450 fish m^{-3}) were tested. The treatments were replicated five times. After 8 weeks of the study, it was established that the total fish yield ranged from 6.0 kg per tank at a stocking density of 150 fish m^{-3} to a high value of 10.33 kg per tank at a stocking density of 450 fish m^{-3}. The total yield of fish increased with increasing stocking density. The lettuce yields ranged from 1.66 kg at a stocking density of 150 fish m^{-3} to the highest value of 3.04 kg at a stocking density of 450 fish m^{-3}. The break-even prices for variable costs could cover the fish cost in the local market, as they were below the sale price of KES 324 ($3.24) per case that the farm could receive in the market. A discount rate of 18% was used to calculate the NPV. It was observed that sales of fish and lettuce at a stocking density of 150 fish m^{-3} were not profitable, but profitability began to increase as density increased.

1.0 Introduction

Aquaculture as a food production practice has been growing rapidly, often exceeding 20% in most Sub-Saharan African countries over the last five decades (Smith, 2019; Chan *et al*., 2019; Tran *et al*., 2019), thus helping to combat food insecurity in areas where aquaculture has been adopted (Asiedu et al., 2017; Kara *et al*., 2018; Soliman and Yacout, 2016). Due to the increasing adoption of aquaculture (Msangi and Batka, 2015), the FAO has projected that by 2025, more than 50% of fish production in Sub-Saharan Africa should be generated by aquaculture to address food insecurity in the region (FAOSTAT and Production, 2016). Yet, aquaculture in Sub-Saharan African countries, including Kenya, is still dominated by extensive and semi-intensive practices (Béné *et al*., 2016), which have resulted in low unit production and often fall short of the projected supply of fish needed to feed the population. Several reports have recommended solutions that integrate aquaculture and other production technologies to aid the development of the sector (Ampadu-Ameyaw et al., 2016; Kraemer-Mbula *et al*., 2018).

Aquaponics is an integrated sustainable food production technology (Lennard and Goddek, 2019) that combines hydroponic production with a recirculating aquaculture system (RAS) (Endut *et al*., 2016; König *et al*., 2018) to enhance both fish and vegetable production (Filep *et al*., 2016). This fish production system has attracted attention and popularity as a bio-integrated model for sustainable food production systems (Kloas *et al*., 2015; König *et al*., 2016; Savidov *et al*., 2005). Aquaponics is a capital and knowledge-intensive food production technology. Adequate capital and operational funds are prerequisites when establishing and running aquaponic systems. The amount needed may vary based on the level of intensification or the size of the system used (Engle, 2015). The items to consider when estimating the costs of this system include the greenhouse structure and materials, the tanks, PVC pipes and other accessories, as well as submersible pumps and filtration systems (Rieger *et al*., 2015; Johnson, 2016). Realistic estimates, especially regarding the kilograms of fish that need to be raised compared to the volume and type of crops that can be grown, along with a clear understanding of the potential risks involved, are of paramount importance. The economic return of any aquaponic system depends on the prices of both the plants grown and the fish raised, with the IRR ranging from 0 to 57% (Rupasinghe and Kennedy, 2010). Engle (2015) states that it is not profitable to operate an aquaponic system based solely on fish, as the cost of rearing fish may be lower than the market price. Many reports associate the profitability of aquaponic systems with the inclusion of the vegetable component (Bailey et al., 1997; Rakocy, 2012; Engle, 2015; Tokunaga et al., 2015). Several studies indicate that fish alone cannot guarantee the profitability of an aquaponics system (Bailey *et al*., 1997; Goodman, 2011; Engle, 2015), while crops like basil and lettuce grown in aquaponic systems can contribute to profitability.

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Several factors would affect the profitability of the system, like losses incurred due to power outages, disease and parasitic infections, the toxic effect of pesticides and other unforeseen risks (Goddek *et al*., 2015). Other issues that affect the profitability of aquaponics are low prices of the vegetables grown, low prices of competing imported fish fillets, high inputs of energy and high labour costs (Goodman, 2011).

Fang et al. (2017) further suggest through their work that when aeration is done moderately, the energy cost to produce 1 kg of fish reduces by 43.69 % compared to the control. Several authors have reported profitability as marginal (Goodman, 2011; Tokunaga, 2015), with net gain only on vegetables but not fish (Love *et al*., 2015). Goddek *et al*. (2015) report a scarcity of data on profitability in large farms because most private companies practising aquaponics keep confidential records and thus do not divulge information on their profitability. Dasgupta and Bryant (2017) in their work report profitability only when big fish and vegetables are sold. Engle (2015) and Rakocy (2012) report profitability only when the correct vegetables are planted in the aquaponic system.

To understand the financial aspects of the system, one has to look also at how it can be further redesigned and reconstructed to increase its capacity and at the same time, the costs around it should be reasonable. The potential financial outcome can differ based on these additional adjustments made to the entire system. It is for this reason that the current study investigates the effects of stocking density on the economic benefits of the *O. niloticus* aquaponics system.

2.0 Materials and Methods

This work was conducted at the University of Eldoret Fish Farm in Uasin Gishu County, Kenya, for 56 days. The floating raft system comprised the following components: a fish rearing tank (0.5 x 0.5 x 0.5 m with a volume of 0.125 m^3), a hydroponic tank (1 x 0.5 x 0.25 m with a volume of 0.125 m^3 and a surface area of 0.5 m^2) for lettuce production, and a plastic sump (0.35 m diameter x 0.4 m height with a volume of 0.025 m^3). The hydroponic component contained fifteen (15) Styrofoam sheets of Polystyrene "bead" board with dimensions of 1 m x 0.5 m x 0.03 m (length, width, and thickness).

Sex-reversed Nile tilapia (*Oreochromis niloticus*) fingerlings average weight of 3g were stocked in the experimental tanks, and they were fed thrice daily to satiation at 1000, 1200 and 1600 hours respectively with a 35% CP-formulated diet. Lettuce, *Lactuca sativa,* seeds were germinated in damp cotton wool strips, and seedlings were transplanted into the floating boards at 10 cm intervals. Water temperatures were maintained at 23±002 ^{o}C.

At the end of the experiment, the plants planted in the floating rafts were carefully removed, washed slightly and blotted using a soft paper towel. This removed all the surface moisture attached to the plant. The individual plants were weighed immediately using an electronic balance. The total weight of fish harvested per tank was taken using a Lab Analytical Balance Digital Electric Precision Scale, 0.001g.

During economic analysis, the costs of the aquaponic unit were calculated to determine the overall capital outlay for the aquaponic unit. Fish and plant yields were computed based on the overall fish and plant biomass at harvest, and the total revenue earned was determined by multiplying the biomass and the market price at the time of the study. An enterprise budget was utilized to determine income, expenses and returns of the aquaponic system under different stocking densities. The profitability of the enterprise was examined using the net returns above variable costs. The break-even price for the enterprise was calculated using the formula.

$$\text{Breakeven price} = \frac{\text{Fixed cost per unit}}{1 - (\text{Variable cost per unit/ Selling Price per unit})}$$

A sensitivity analysis was used to calculate the net returns due to variations in alternative market prices and yield variability on breakeven prices. The market price variation ranged from \$ 4.00 to 6.0 kg^{-1}. During sensitivity analysis, the Excel Package, What-if Analysis, and 1-way and 2-way Tables were utilized to investigate the variability of single and combined variables, respectively, affecting the yield variability or break-even prices accordingly. Cash flow projections were based on the aquaponic stocking densities and were computed using Net Present Value analysis and Internal Rate of Return as detailed elsewhere (Bailey *et al*., 1997).

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Results

Economic performance of the aquaponic system

To construct an aquaponics system, the total capital calculated was approximately $624.5 for each stocking density unit (Table 1). The main units of aquaponics were the reservoir tanks, the RAS composed of fish tanks and the hydroponic unit composed of a hydroponic unit (0.07 m^3) and a sump. The RAS unit accounted for approximately 90% of the costs, with the remaining 10% accounted for by the hydroponic unit. The cost was reduced by designing the water to flow through gravity from the reservoir tank.

Table 1: Items required, quantity, unit cost, and total cost for the fish and *Lactuca sativa* production components of the aquaponic unit

Items	**Unit**	**Unit cost**	**Total cost ($)**
RAS component			
Aeration tubes	3	1.00	3
Air pump	3	10.00	30
Airstones	5	2.50	12.5
Bench platform	1	80	80.00
Biofilter system	5	10.00	50.00
Plastic tanks	5	40.00	200.00
Piping system/valves	Assorted		20.00
Reservoir tanks (2000 L)	1	60	60.00
Submersible pump	5	15.00	75.00
Sump/waste pipe	5	3.00	15.00
Styrofoam	1	10.00	10.00
PVC glue	500 ml	2.00	2.00
Subtotal			**557.50**
Hydroponic units			
Hydroponic tank	1	35.00	35.00
Pipes and fittings	Assorted		30.00
Plant pots	120	0.017	2.00
Subtotal			**67.00**
Total aquaponic unit			**624.50**

The total yields of *O. niloticus* and *L. sativa* in each treatment unit are shown in Table 2. Fish yield increased with increasing stocking density, ranging from 6 kg per tank at a stocking density of 150 fish m^{-3} to 10.33 kg per tank at a stocking density of 450 fish m^{-3}. *L. sativa* yields ranged from 1.66 kg at a stocking density of 150 fish m^{-3} to the highest value of 3.04 kg at a stocking density of 450 fish m^{-3}.

Table 2: Yields of *O. niloticus* and *Lactuca sativa* at different stocking densities after 56 days

	Stocking density (fish m^{-3})		
	150	**300**	**450**
Total fish yield (kg m^{-3})	6.00 ± 1.42	8.56 ± 1.43	10.33 ± 2.55
Lactuca sativa yield (kg m^{-3})	1.66 ± 0.98	2.76 ± 0.23	3.04 ± 0.23

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Based on the yields and other operating expenses, the enterprise budget of the aquaponics system consisting of *O. niloticus* and lettuce at different stocking densities was determined (Table 3). All the treatments posted positive returns and were viable investments. The break-even prices for variable costs were able to cover the cost of fish and lettuce in the local market, as they were below the sale price of $ 4.00/kg and $ 3.00/kg, respectively, that the aquaponic systems were able to get in the market.

Table 3: Overall enterprise budgets for *O. niloticus* and *L. sativa* in a model aquaponics system at different stocking densities for 56 days

	Fish stocking density		
	150 fish m^{-3}	300 fish m^{-3}	450 fish m^{-3}
Survival (%)	93.3	90	90.2
Mean fish yield (kg m^{-3})	6	8.56	10.33
Mean *Lactuca sativa* yield (kg m^{-3})	1.66	2.76	3.04
Total revenue from fish ($)	42.00	59.92	72.31
Revenue from *Lactuca sativa*	4.98	8.28	9.12
Gross revenue	**46.98**	**68.20**	**81.43**
Variable costs			
Cost of feeds	1.3254	1.869	2.08392
Field labour	15.00	15.00	15.00
Cost of maintenance of equipment	3.50	3.50	3.50
Water	6.50	6.50	6.50
Electricity	8.00	8.00	8.00
Miscellaneous	6.00	6.00	6.00
Sub-total variable costs	**40.325**	**40.869**	**41.084**
Interest in operating costs	7.25857	7.35642	7.3951056
Total variable cost (TVC)	**47.584**	**48.225**	**48.479**
Fixed costs			
Bench platform	8.00	8.00	8.00
Amortization	2.00	2.00	2.00
Interest in the fixed-cost	1.80	1.80	1.80
Total fixed cost	11.80	11.80	11.80
Total cost (TC)	59.384	60.025	60.279
Net returns above TVC	-0.604	19.975	32.951
Net returns above TC	**-12.404**	**8.175**	**21.151**
The break-even price for fish	1.967	1.379	1.142

Assumption: The market price of O. niloticus was $ 4.00 kg$^{-1,}$ and Lettuce was $3.00 kg^{-1}.

The cash flow projections were made over a 5-year cycle within a year for each of the aquaponic units. There was initial cash to buy capital items during the establishment of the research unit. In the following years, there were operating expenses and revenues generated from sales. The net present value (NPV) and internal rate of return (IRR) were determined for each of the model units. A discount rate of 18% was used to ascertain the NPV. It was observed that sales of fish and *Lactuca sativa* at a stocking density of 150 fish m^{-3} were not profitable. However, all the other stocking densities were profitable except at 300 fish m^{-3} increased with increased stocking density. Investors must decide their necessities for adequate returns while choosing their aquaponic facility size. On the off chance that the IRR is excessively low, at that point other cost-saving efficiency opportunities must be found.

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Table 4: Net present value (NPV) and internal rate of return (IRR) for the model aquaponics at different stocking densities

Years	150 fish m^{-3}		300 fish m^{-3}		450 fish m^{-3}	
	NPV	IRR	NPV	IRR	NPV	IRR
1	-120.615	4.2	-11.035	16.2	-120.615	16.2
2	-85.452	5.7	-81.432	16.7	55.4521	16.7
3	-76.106	7.2	-46.1062	17.2	56.1062	17.2
4	-56.979	8.4	-16.541	17.8	36.97.95	17.8
5	-10.262	10.7	0.264	16.7	10.26.15	16.7

The results of the sensitivity analysis, which demonstrate how variations in production costs affect the profitability of the enterprise under different stocking density scenarios, are presented in Table 5. Within the range of profitability provided, production costs above $60 per cubic meter were not profitable, regardless of the stocking density. Additionally, at a low stocking density of less than 150 fish per cubic meter, production costs exceeding $44.00 per cubic meter led to negative returns and should not be considered. Stocking densities ranging from 240 to 500 fish per cubic meter appear to yield profits throughout most of the production cost range, and the potential profit size is moderately significant.

Table 5: Sensitivity analysis of the profitability of the aquaponics to alternative variations in the cost of production

Market Price (Kshs)	Stocking density (fish m^{-3})							
	122.88	153.6	192	240	300	360	432	518.4
4.00	18.03	21.531	25.91	31.40	38.24	45.08	53.31	63.17
12.00	34.03	37.53	41.91	47.40	54.24	61.09	69.31	79.17
28.00	42.03	45.53	49.91	55.40	62.24	69.09	77.31	87.17
36.00	34.03	37.53	41.91	47.40	54.24	61.09	69.31	79.17
44.00	18.03	21.53	25.91	31.40	38.24	45.09	53.31	63.17
52.00	-5.98	-24.69	1.91	7.40	14.24	21.09	29.31	39.17
60.00	-37.98	-34.47	-30.09	-24.61	-17.76	-10.91	-26.94	7.17

At a stocking density of 300 fish m^{-3}, the total cost involved is $ 28.00. Profitability remains positive up to a cost price of $ 52.00 and turns negative past the $ 52.00 point. The same scenario is shown for stocking densities between 300 to 432 fish m^{-3} according to the model used. At higher densities, i.e., past 432 fish $m^{-3,}$ profitability or positive net returns can be achieved. As the density reduces from 300 to 192, a positive net return is assured up to the cost price of $ 52.00, whereas densities below 192 only produce a positive net return up to $ 44.00.

Discussions

Recirculating aquaculture systems provide the economic benefit of fish harvest and plant harvest, as well as difficult to quantify low water consumption (Rakocy *et al*., 2016; Engle, 2015). Although there is high fish production that enhances the highest net profit, it likewise includes economic investment as electricity is consumed by the submersible pumps for water flow. The merit of the aquaponic system cuts down this cost to some level by producing a second crop of vegetables, which improves the system's profit margin (Tokunaga *et al*., 2015). According to Quagraine *et al*. (2017), the initial investment is normally higher because of the cost of installation. The inclusion of a plant like lettuce, which can be harvested at least thrice during the overall fish production period, thereby increasing the revenue of the aquaponic system

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In the current study, the total production yields of Nile tilapia and L. sativa in each treatment increased with higher stocking density. This is consistent with work done by Yoo et al. (2016), who linked plant yields to the stocking density of fish. Based on the yields and other operating expenses, the enterprise budget of the aquaponics system consisting of O. niloticus and lettuce at varying stocking densities showed that all treatments, except for the stocking density of 150 fish m-3, posted positive returns to risk and were viable investments. This agrees with Shoko et al. (2016), who reported positive net returns for all stocking densities used. Therefore, this implies that stocking densities above 300 fish m-3, if selected, will yield a profit. Thus, profitability increased with greater stocking density, a phenomenon also observed and reported by Rahman et al. (2006) and Shoko et al. (2016). Stocking densities of 300 and 450 fish m-3 had significant positive effects on production, suggesting that higher densities may be employed to achieve greater biomass and enhance the profitability of the system. This aligns with Rahman et al. (2006), who linked density to higher yields and profitability.

The break-even prices in the current experiment increased with increasing stocking density. The break-even prices for variable costs were able to cover the cost of fish in the local market as they were below the sale price of $ 0.10 per case that the treatments used were able to receive in the market. Goodman (2011), Tokunaga *et al*. (2015), Engle (2015) and Shoko *et al*. (2016) commend that the break-even prices are important financial aspects to be considered in any enterprise because they indicate the profitability of the operation in the short and long term, provided the commodity price at the market is higher than the break-even prices obtained.

The sensitivity analysis shows how variations in the cost of production affect the profitability of the enterprise under different stocking density scenarios. It indicates that enterprise viability is highly sensitive to changes in sale prices received for the harvested product, highlighting the most significant impact on annual returns (Trapani et al., 2014). According to the current study, the range of profitability suggests that production costs above $60.00 m-3 were unprofitable, regardless of the stocking density. Meanwhile, at a low stocking density below 150 fish m-3, production costs above $44.00 m-3 led to negative returns and should not be allowed. Stocking densities ranging from 240 to 500 fish m-3 appear to yield profit across most of the range of production prices, and the potential profits are moderately substantial.

Conclusion

Generally, the total yield of fish and lettuce increased with increasing stocking density. The enterprise budgets for aquaponic farms with different stocking densities for fish and lettuce production indicated all the treatments posted positive returns to the risk and were viable investments.

The cash flow projections were made over 5 years for each of the units, with the net present value (NPV) and internal rate of return (IRR) calculated for each of the model farms. A discount rate of 18% was used to calculate the NPV. The sales of fish and *L. sativa* at a stocking density of 150 fish m^{-3} were not profitable and hence not worthwhile.

The break-even prices for variable costs could cover the fish cost in the local market, as they were below the sale price of Ksh 10 per case that the farm could receive in the market. At a discount rate of 18%, it was observed that sales of fish and L. sativa at a stocking density of 150 fish m-3 were unprofitable. All other stocking densities were profitable except for 300 fish m-3, and profits increased with higher stocking densities.

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EVALUATION OF AQUAPONIC PRODUCTION OF POK CHOI (*Brassica rapa*) AND FRESH WATER PRAWN (*Macrobrachium rosenbergui*)

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This study examined how using the fresh water prawn (*Macrobrachium rosenbergui*) at two different stocking densities impacts production of the Chinese Cabbage, Pok Choi (*Brassica rapa*) compared to Deep-Flow Culture Hydroponic Raceway (DFCHR) production of Pok Choi without fresh water prawns. The experiment was done at a commercial aquaponic project near Cairo, Egypt. The aquaponic system was composed of four, 8 m^3 fiberglass fish tanks, a solids removal device, net tank, sump, pump and nine DFCHR (30 m x 1 m x 0.75 m) with a water surface area of 30 m^2 per raceway. The aquaponic system was covered by raft made of Expanded Polystyrene (EPS). Pok Choi seedlings were inserted into a light weight mesh net pots within the rafts at a density 36 plant/m^2. The prawn post-larvae (PL30) weight typically ranged from 0.01 to 0.09 g and length ranged from 0.8 to 1 cm. The DFCHR were stocked at densities of 5 and 10 PL30/m^3 respectively for a rearing period of 55 days versus DFCHR without prawn. Each treatment had three replicates. The prawns were fed three times a day using a 32% crude protein and 5% crude fat commercial extruded sinking tilapia formulated diet. The water quality parameters were monitored daily (salinity; dissolved oxygen – DO; pH and temperature(and water chemistry parameters were monitored weekly (total ammonia nitrogen – TAN; nitrite; nitrate; potassium; and soluble reactive phosphorus - SRP). In addition, the other main culture parameters that were monitored included: plant/ freshwater prawn biomass growth, feed consumption, survival, final Pok Choi and prawn production at harvest).

Water quality parameters in both experiments were within the acceptable range for prawns and all increased as prawn stocking density increased (0.25-0.32 ppt salinity; 3.1–5.3 mg/L DO; 7.2-8.4 for pH; 0.012- 0.029 mg/L for TAN; 0.030–0.034 mg/L for nitrite; 0.001-0.002 mg/L for nitrate; 1.2-3.1 mg/L, for potassium 5.2-5.6 mg/L and SRP for 2.4-4.9 mg/L). The final prawn weight was 15.3 ± 4.1 g and 13.5 ± 3.6 g for 5 and 10 PL30/m^3, respectively. Specific growth rate (SGR) and survival rate was reduced with increasing stocking density, whereas food conversion ratio (FCR) increased at the higher stocking density. Aquaponic systems with the lower prawn stocking densities (5 PL30/m^3) performed better than 10 PL30/m^3. The growth performance of prawns in terms of SGR, survival rate and FCR were significantly influenced by the stocking density. The SGR was estimated at 2.7% and 2.6% at 5 PL/m^3 and 10 PL30/m^3, respectively. The survival rate was 75% and 69% at 5 PL30/m^3 and 10 PL30/m^3, respectively. The FCR was reported to 1:1.9 and 1:2.1 at 5 PL30/m^3 and 10 PL30/m^3, respectively. The prawn biomass at harvest was 57.4 and 93.2 gm/m^3 at 5 PL30/m^3 and 10 PL30/m^3, respectively. The water chemistry with prawn in both experiments was significantly different for nitrate, potassium, and SRP in the high prawn density treatment, which was impacted positively on the mean of plant weight at harvest, 750 and 545 gm/Pok Choi, at 5 PL30/m^3 and 10 PL30/m^3, respectively because the prawns damaged the plant roots. In the raceways without prawns, the Pok Choi has reached 790 gm/plant. This presentation will report on the actions needed to achieve efficient production and economic returns.

FINDING SOLUTIONS WITH FAMILY FISH FARMS IN MADAGASCAR TO ADAPT TO CLIMATE CHANGE

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In Madagascar, between 1990 and 2020, average temperatures increased, dry seasons became longer and a downward trend in rainfall was observed. Over this period, the country was also hit by 64 cyclones and 6 periods of severe drought (UNFCCC, 2022).

Fish farming (*Cyprinus carpio* and *Oreochromis niloticus*, mainly) in rice fields or dam ponds is practiced by more than 20,000 small family producers who are particularly vulnerable to climate change: the lack of water at the beginning of the fish farming season forces them to postpone by 1 to 3 months the stocking period (see figure), or even more given the increased risk of flooding at the beginning of the rainy season. Fish farmers must therefore adapt to a new breeding calendar with colder and drier conditions and greater risk management. A working approach with fish farmers has been set up to support the production of solutions, both on a technical level and organizational, combining methods such as innovations tracking (Salembier, 2019), action research protocols and co-active search for solutions (Darré, 2006).

Techniques for reproducing common carp (*C. carpio*) later during the breeding season have been developed, with some fish farmers delaying spawning by a few months, or spawning their carp a second time, a few months apart. These techniques have been widely adopted by farmers' hatcheries. In order to grow these stocked fries later, access to water often needs to be improved. Groups of fish farmers collectively install and manage hydro-agricultural structures to extend the fish farming cycle. In other cases, innovative social organizations are created to deal with water shortages or floods, such as the occasional pooling of livestock with shared redistribution rules. Finally, to compensate for a drop in productivity in the cold season, fertilization and feed supplement tests are carried out in order to improve the technical and economic performance of livestock farming.

The simultaneous implementation of these individual and collective innovations allows for systemic changes that strengthen the resilience of fish farmers.

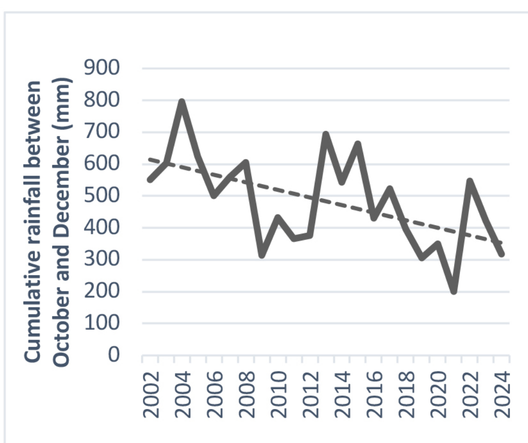

Figure 1 : Cumulative rainfall between October and December in a weather station in the Highlands of Madagascar (Muller B., personal communication).

DOMESTICATION AND CULTURE POTENTIAL OF NATIVE TILAPIINE CICHLIDS, *Oreochromis variabilis* AND *Oreochromis esculentus*) IN CAGES WITHIN LAKE VICTORIA, KENYA AS A CONSERVATION STRATEGY

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Capture fisheries has for decades contributed significantly to food security, employment and livelihoods. However, catches trends are indicating a major decline with commercially important indigenous species in the Great lakes fast disappearing. The study investigated the potential of cage aquaculture systems contribution towards the conservation of Lake Victoria native tilapiines. Wild brooders of *Orechromis esculentus* and *Oreochromis variabilis* were sourced from colonial dams and satellite lakes along the Lake Victoria basin, Kenya, and domesticated for mass multiplication at KMFRI Kegati Aquaculture Research Center-Kisii. To evaluate the performance, of the F1 generation of the native species, a 3x2x1 factorial l design with three replicates was implemented using cages in Lake Victoria. The stocking fingerlings (5±0.01g) was at a density of 30 fish/m³ and subjected to 40%, 35%, and 30% CP diets over a six-month period. The 40% CP diet, rich in fishmeal and soybean meal, was used in the early phase to support juvenile growth, followed by 35% and 30% CP diets in the mid and late grow-out stages, respectively, to match declining protein requirements and reduce feed costs. This step-down feeding strategy revealed that O. niloticus utilized the diets more efficiently than the native species, likely due to its domestication history and prior selection for aquaculture traits. Further, wild fish biodiversity around the cages was assessed at baseline, mid-term, and at the end of the experiment using gill nets. *O. niloticus* performed significantly better (185.39±0.27g) compared to *O. esculentus* (47.26±0.08g) and *O. variabilis* (46.03±0.12g). Meanwhile there was a signifiacant difference across species on survival with *O. niloticus* having the highest survival (88.5%) and the best FCR (1.77). The poor performamnce of O. esculentus and O. variabilis is due to adaption challenges under confinement and lack of a selection for aquaculture traits unlike *O. niloticus*. Therefore, there is an urgent need for continued research on the culture biology of these native species, alongside expanded propagation programs, to enhance their survival and support biodiversity restoration efforts in Lake Victoria.

ARTEMIA POTENTIAL FOR HUMAN FOOD: A COST-EFFECTIVE NUTRITION-SENSITIVE BUSINESS MODEL FOR FOOD, NUTRITION AND ECONOMIC SECURITY

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This study explores the transformative potential of Artemia (brine shrimp) as a human food source, positioning it as a cost-effective, nutrition-sensitive business model to address food, nutrition, and economic security in vulnerable and climate-affected regions. Traditionally used in aquaculture, Artemia is rich in high-quality protein (40–65%), essential omega-3 fatty acids (EPA and DHA), iron, zinc, and calcium, making it a sustainable solution to combat malnutrition, particularly during the critical first 1000 days of life. The study integrates desk reviews, expert consultations, nutritional calculations, and conceptual modeling to assess Artemia's viability for human consumption, its scalability in saline environments, and its market potential. It highlights how Artemia-based products such as kebabs, omelets, and fortified powders can support maternal and child nutrition, generate women-led income opportunities, and create climate-resilient food systems. Despite promising nutritional and environmental profiles, the report identifies key challenges, including data gaps, consumer acceptance, regulatory frameworks, and supply chain development. To unlock Artemia's full potential, the report recommends strategic investments in research, pilot programs, market development, and policy engagement. By advancing Artemia as a human food, stakeholders can simultaneously tackle pressing issues of protein scarcity, micronutrient deficiencies, poverty, and climate resilience making Artemia a promising innovation for global food and nutrition security.

TABLE 1: Key Nutrients in Artemia and Their Contribution to Daily Requirements (Using average values from the nutrient range reported by Léger et al., the table below illustrates how 100g of dry Artemia contributes to the Recommended Daily Intake (RDI) for an average adult)

Nutrients	**Content in 100g Dry Artemia**	**Adult RDI**	**% of RDI Provided by 100g Artemia**
Iron	~1500 µg/g = 150 mg	18 mg	833%
Zinc	~150 µg/g = 15 mg	11 mg	136%
Calcium	~2.5 mg/g = 250 mg	1000 mg	25%
Phosphorus	~10 mg/g = 1000 mg	700 mg	143%
Selenium	1.1 µg/g = 110 µg	55 µg	200%
Omega-3 (EPA)	~10% of total fats = ~4 g	0.25 g	1600%
Omega-3 (DHA)	~1% of total fats = ~0.4 g	0.25 g	160%
Omega-6 (Linoleic Acid)	~5% of fats = ~2 g	17 g	12%

Note: However, it is important to note that the exact micronutrients and fatty acids such as omega-3 and omega-6 content in Artemia can vary based on factors such as their diet, environmental conditions, and specific species. For precious nutritional profiling of Artemia requires further research, as current data in this area remain limited.

THE EFFECT OF VARYING MOLASSES CONCENTRATION IN PROBIOTIC PREPARATION ON THE GROWTH PERFORMANCE OF NILE TILAPIA (*Oreochromis niloticus*)

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The use of probiotics in aquaculture enhances fish growth and sustainability, yet the role of prebiotics like molasses in optimising probiotic efficacy remains underexplored. This study investigated the effects of varying molasses concentrations (0%, 2.5%, 5.0%, and 7.5% v/v) in Sanolife Pro-W probiotic preparations on the growth performance of Nile tilapia (Oreochromis niloticus) juveniles. A completely randomised design was employed, with 180 juveniles (initial weight: 10-15 g) assigned to four treatment groups, each with three replicate 50-L tanks, over three weeks at TANLAPIA Company Ltd., Bagamoyo, Tanzania. Growth parameters (weight gain, feed conversion ratio, specific growth rate) were measured weekly, and water quality was maintained within optimal ranges (temperature 26-30°C, DO >5 mg/L). One-way ANOVA revealed significant differences in mean weights among groups $(3, 8) = 79.08$, $p<0.001$), with the 5.0% molasses group exhibiting the highest average weight across time points. Trend analysis indicated consistent superiority of the 5.0% group, while the 7.5% group showed a weight decline at the final measurement. These findings suggest that 5.0% molasses optimises the efficacy of Bacillus-based probiotics, enhancing tilapia growth. However, weight gain trends suggest the 5.0% molasses group had the highest SGR, reflecting faster growth, and likely a better FCR due to enhanced nutrient utilization. The 5.0% concentration likely optimized Bacillus activity, improving gut health and feed efficiency, as supported by (Verschuere et al., 2000).This cost-effective approach could improve aquaculture profitability and sustainability in Tanzania's blue economy. Further research is needed to elucidate the mechanisms underlying molasses-probiotic interactions and long-term impacts on fish health and water quality

THE AQUACULTURE NETWORK FOR AFRICA

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The Aquaculture Network for Africa (ANAF) was established as a public-sector network in 2006, to coordinate and facilitate scientific and technical information exchange in aquaculture, regional and sub-regional collaborative aquaculture research, training of fish farmers and extension workers and technology transfer to accelerate sustainable aquaculture development within Africa. Initially founded as a working group comprising six-member countries of FAO Committee on Inland Fisheries (CIFA), ANAF has now transformed to become the AU platform of Directors of Aquaculture whose role is to support, facilitate, coordinate and promote the establishment of partnerships, including with Africa's Non-State Actor Networks, for the coherent implementation of AU policies and strategies on sustainable aquaculture development in Africa. Its membership has expanded to include all the countries of the Africa Union. Integration within the African Union was requisite for assuring the long-term commitment of African Union Member States towards establishing aquaculture development sustainably.

Thus, over the next five-years ANAF aims to strengthen multi-stakeholder sectoral initiatives for aquaculture information and knowledge generation and sharing, to foster coherent sustainable aquaculture development across the continent. This approach is guided by the Pan-African Policy Framework and Reform Strategy for Fisheries and Aquaculture in Africa (PFRS) that advocates all AU Member States to develop their fisheries and aquaculture sectors in a manner that focuses on *(i)* productivity, *(ii)* profitability, *(iii)* sustainability, *(iv)* wealth generation, *(v)* social welfare, nutrition and food security, *(vi)* regional management of shared resources and *(vi)* strengthening south-south (bilateral and regional) cooperation while factoring in resilience building.

MULTIPLICATION OF THE FRESHWATER ZOOPLANKTON (*Moina* sp) FED ON PIG SLURRY IN VARIOUS LAB CONDITIONS

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The availability of common carp fry is an obstacle to the development of rice-fish culture in the Malagasy highlands. Survival of juveniles during the rearing phase is generally low (< 10%). This is linked to several factors, including insufficient zooplankton as live prey as initial feed. To remedy this situation, we assessed the multiplication of a small freshwater parthenogenetic cladoceran, *Moina* sp., which is widely produced in Asia to feed farmed fish larvae.

A local strain of moina found in the Malagasy highlands was used. Three tests were carried out to evaluate 1) the effects of the concentration of pig slurry (0, 0.5, 1, 2, 3 g L^{-1} wet weight, ~50% dry matter), 2) the effect of the prior adaptation of the moinas to the culture conditions and 3) the use of a phytoplankton solution "green water" as culture media. The green water was previously produced with pig slurry during 5 days and partially diluted (67%) before its use for moinas culture. Each treatment was applied to 10 tubes filled with 40 mL and initially stocked with 8 moinas (200 moinas L^{-1}). Water temperature was kept constant (~27.8°C) and permanent artificial lighting was applied. An exhaustive count of moinas was done in all tubes, every day for 14 or 21 days.

With clear water and adapted moinas, the pig slurry concentration 2 g L^{-1} was optimal. After prior adaptation, 1 adapted moina produced an average of 51 moinas during the 3.7 days increase phase while 1 non-adapted moina produced only 30. The numbers increased rapidly from day 2 to day 5, reaching 402 moinas $tube^{-1}$ (10 050 moinas L^{-1}), before collapse. In both experiments, the increase phase was preceded by a latent phase lasting 1.7 days. Tube collapse was accompanied by a deterioration in culture conditions with nitrite up to 3.7 mg L^{-1}. Green water allowed to extend the culture duration (Figure 1A). An experiment is ongoing to test if phytoplankton improved the water quality.

Local moinas have good multiplication potential when fed pig slurry. An estimate show that 1.3 kg of dry slurry would produce ~1 kg of fresh, drained moinas. Future experiments should test production at a larger scale with a combination of slurry and green water.

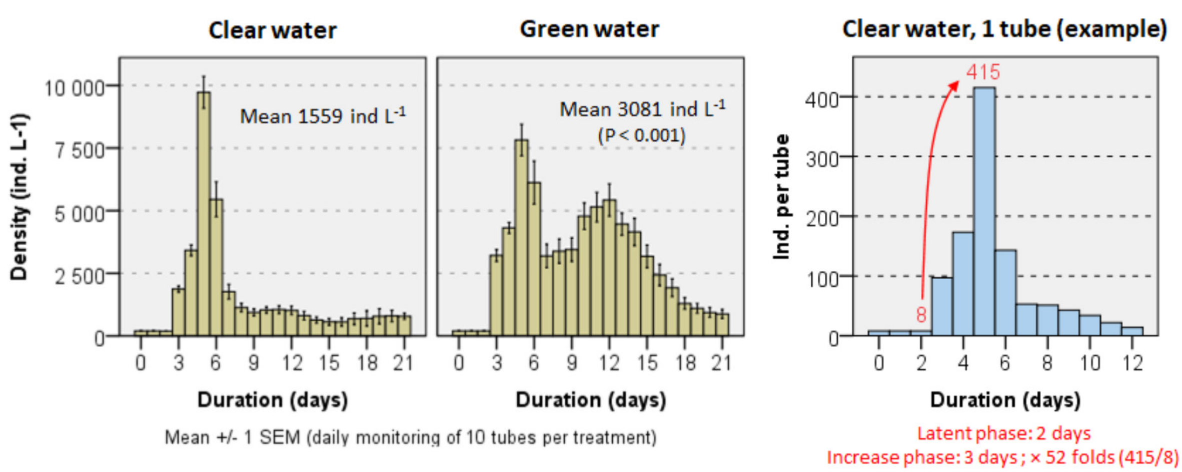

Fig1: Evolution of the number of live moinas fed with pig slurry at 2 g L^{-1} wet weight.

EXOGENOUS PHYTASE FED TO NILE TILAPIA (*Oreochromis niloticus*) REDUCES REQUIREMENT FOR SUPPLEMENTED PHOSPHORUS AND THE IMPACT ON THE AQUATIC ENVIROMENT

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Excessive use of phosphate in the aquatic environment is well documented to cause serious eutrophication in water courses. Plant ingredients contain a significant quantity of Phytate Phosphorus (PP) ~65-70% that is poorly utilised in fish species and is a known anti-nutritional factor. As tilapia feed formulations are typically derived from 90-95% plant material there is a significant opportunity to utilise this PP. In terrestrial monogastric nutrition phytase enzyme unlocks considerable (PP) and significantly enhances animal performance. A 93 day feeding trial was conducted to test the performance of a phytase enzyme applied post pellet to an extruded tilapia feed (1500FTU/kg). A 50% reduction in inorganic P supplementation which is a finite and expensive material, was tested to assess the impact of growth performance indices when using phytase to unlock the (PP) that is currently poorly utilised within fish.

Three experimental diets were produced:

- Control feed (MCP 1.9%)
- Negative Control (MCP 0.8%) (NC)
- NC (MCP 0.8%) + Phytase 1500 FTU

Each diet was randomly assigned to quintuplicate groups, (30 fish tank, N=150 in 350l round tanks) Fish were raised in a recirculating system and maintained at a water temperature of 27.7 ± 0.04°C. After 93 days of feeding it was demonstrated that it is possible to successfully replace at least 50% Mono Calcium Phosphate (MCP) with a phytase enzyme and have significantly positive effects on fish performance as detailed in table 2 below.

Table 1. Formulation of the experimental diets.

Ingredients, %	NC	NC+1500FTU	MCP
Soyabean meal	25	25	25
Wheat bran	25	25	25
Maize gluten 60	15.87	15.87	16.05
Maize	13.74	13.74	12.43
Rapeseed meal	10	10	10
Fishmeal	5	5	5
Monocalcium phosphate	0.805	0.805	1.901
DL Methionine	0.006	0.006	0.007
Soya oil	1.8	1.8	1.8
Salmon oil	1.8	1.8	1.8
Vitamin & Mineral premix	1	1	1
OptiPhos Plus 5000L	0.00	0.03	0.00
Calculated analysis, %			
Moisture*	11.5	11.5	11.3
Protein	33	33	33
Fat	7	7	7
Fibre	5.4	5.4	5.4
Ash	5.6	5.6	6.5
Ca	0.55	.55	0.74
P	0.98	0.98	1.22
Av P	0.40	0.40	0.60
GE (MJ/kg)	18.1	18.1	18.1

A STUDY ON PARASITIC INFECTIONS ASSOCIATED WITH FARM-RAISED *Clarias gariepinus* IN SUNYANI MUNICIPALITY

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As Aquaculture grows rapidly world-wide, it is note-worthy that parasitic infections are contributing to economic loss due to mortalities, tissue damage and stunted growth of fish. Hence, findings on the presence, intensity, prevalence of parasites in aquaculture holding facilities, coupled with the likelihood of cross-transmission in culture systems is important in developing effective prevention and control protocols. In view of the afore-stated points, this study investigated the prevalence rate, relative abundance and mean intensity of parasites infecting cultured African Catfish (*Clarias gariepinus*) in three fish farms located in Abesim, Fiapre and Kuotokrom in Sunyani Municipality, Ghana.

Organs (Gills, Stomach, Intestine and Skin) from one-hundred and twenty (120) fish samples across the three farm locations were harvested over a period of two (2) months. Parasitic examination was carried out on them to determine parasite loads in the harvested fish samples by using standard laboratory procedures.

Results showed the occurrence of four (4) parasites: protozoans, cestodes, nematodes and trematodes which were mostly organ specific in terms of infection. The protozoa parasites observed were *Ichthyopthirius spp*, *Trichodina spp* and *Costia spp*. The prevalence of the parasites varied per farm location and sex of fish. Thirty-three (33) out of fifty-six (56) males with weight range (500-799) g had the highest (58.9%) prevalence rate. This indicated a positive relationship between size, sex and prevalence of infection. Abesim had the highest parasites (nematode) abundance of thirty (30), the highest infestation of parasite loads: *Ichthyophthirius multifilis*, *Trichodina* and *Costia* were recorded in the fish skin. The highest (217.5) relative abundance of infestation was recorded at Abesim while, Kotokroum had the highest (429.4) mean intensity of infestation. The high prevalence rate, relative abundance and mean intensity of these parasites are of public health concern and a threat to both fish farmers and fish consumers in Sunyani.

It is therefore recommended that best farm management practices are employed in the production of safe farm-raised fish for sustainable food security.

GENDER PARTICIPATION IN INTEGRATED MULTI-TROPHIC AQUACULTURE (IMTA): PROMOTING INCLUSIVE COASTAL MARICULTURE IN KENYA

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This study examines gender participation in Integrated Multi-Trophic Aquaculture (IMTA) across Lamu, Tana River, Kilifi, Mombasa, and Kwale counties, focusing on mariculture and seaweed farming. Using a mixed-methods approach, surveys and interviews were conducted with 750 farmers and 50 stakeholders in October 2024, applying multi-stage sampling for gender and regional representation. Kwale recorded the highest female participation (62%), attributed to its strong seaweed industry. Aquaculture was the main occupation for 64% of respondents, with women playing critical roles in feed preparation, net mending, and marketing. However, educational disparities and low youth participation were evident, alongside barriers such as limited access to fingerlings, training, and market infrastructure, disproportionately affecting women. Findings highlight mariculture's potential for economic empowerment and social inclusion, with female farmers highly motivated to expand their involvement. Policy recommendations include decentralized hatcheries, mobile training services, and women-led cooperatives to promote equitable IMTA adoption and sustainable coastal livelihoods.

Kwale emerges as a key region for female mariculture involvement, highlighting favorable socio-economic conditions that support women's participation. Strengthening training accessibility, market infrastructure, and policy frameworks will enhance gender inclusion in Kenya's coastal aquaculture.

Table 1: County-Level Gender Participation in Mariculture

Region	Total Population	Average Age (years)	Males (%)	Females (%)	Weekly Fish Value Chain Engagement
Kilifi	269	45	37.5	31	9
Kwale	375	45	39.2	62	48
Mombasa	149	42.05	23.3	15	20
Total	793	-	360	433	77

ENHANCING BUSINESS MANAGEMENT SKILLS AND EXPORT PREPAREDNESS OF SMALL AND MEDIUM ENTREPRENEURS IN AQUATIC FOOD SYSTEMS IN SOUTHERN AFRICA USING A MIX OF FORMAL BUSINESS TRAINING METHODS AND HANDHOLDING APPROACH

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Small and medium entrepreneurs (SMEs) have been identified as a vehicle that will deliver nutritional outcomes whilst fostering regional economic integration. A total of sixty-two (62) – 31 from Tanzania and 31 from Zambia - were trained in business management and export trade facilitation. The SMEs were selected from a pool of SMEs in aquatic food systems in the two countries using 10 variables ranging from production volumes, products offered and compliance with regulatory agencies. The training covered three thematic areas i.e. business management, food safety and standards and trade facilitation. The training approach comprised interactive on-site face-2-face training, practical sessions of auditing processing facilities, motivational talks from other SMEs that had already entered high premium markets, dialogues during business platforms and, handholding of SMEs to help them complete certain critical processes to access formal markets and complete regulatory requirements. The approach helped SMEs overcome what seemed complex processes; establish networks and trust with business development service providers in public and private sectors and created awareness of existing resources for SMEs including funding opportunities. Dialogue during business platforms gave SMEs and opportunity to engage with financial houses, regulators and other service providers and map existing opportunities offered by these stakeholders. Business clinics helped SMEs to identify areas for improvement and growth and, created additional opportunities for customized learning depending on the needs of targeted SMEs. Handholding the SMEs helped them to gain confidence, boost their morale and forge partnerships. Several SMEs won awards at marketing events and had their processing facilities certified by regulatory authorities. The process of handholding however, proved time demanding and requires personalized support.

HARNESSING NATURAL ECOSYSTEMS IN RICE-FISH FARMING: LESSONS FROM CASE STUDIES OF DESIRA PROJECT

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This study aimed to determine the best practice in integrated rice fish in Malawi. The study was conducted at two research stations central region and southern region representing two different ecological zones and thirteen local farmers' fish farms as on farm trials. The treatments for each farm included five trial practices which were; Kilombero rice and *Oreochromis shiranus*, Kilombero rice and *Coptodon rendalli*, Kilombero rice only, *O. shiranus* only and *Coptodon rendalli* only. Results shows that integration of Kilombero rice with *Coptodon rendalli* emerged as the most profitable and widely preferred option by farmers. This option consistently delivered high net returns and Marginal Rates of Return (MRR) exceeding the 50% threshold, making it suitable for scaling. In addition, rice-fish integration enhances climate resilience and food security. With climate change threatening traditional farming systems, rice-fish integration offers an adaptive solution that promotes resilience and efficiency, reducing dependence on synthetic fertilizers and pesticides, while promoting soil fertility and water quality. This integrated approach shows potential in mitigating the impacts of climate change by optimizing land and water use, and providing diversified income sources for farmers. Additionally, the presence of fish aids in pest control and nutrient cycling, leading to healthier rice crops and improved yields. Therefore, scaling up rice-fish integration in Malawi could contribute to sustainable agriculture, climate resilience, and rural development, warranting further investment and policy support.

HARNESSING NATURAL ECOSYSTEMS IN RICE-FISH FARMING: LESSONS FROM CASE STUDIES OF DESIRA PROJECT

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This study aimed to determine the best practice in integrated rice fish in Malawi. The study was conducted at two research stations central region and southern region representing two different ecological zones and thirteen local farmers' fish farms as on farm trials. The treatments for each farm included five trial practices which were; Kilombero rice and *Oreochromis shiranus*, Kilombero rice and *Coptodon rendalli*, Kilombero rice only, *O. shiranus* only and *Coptodon rendalli* only. Results shows that integration of Kilombero rice with *Coptodon rendalli* emerged as the most profitable and widely preferred option by farmers. This option consistently delivered high net returns and Marginal Rates of Return (MRR) exceeding the 50% threshold, making it suitable for scaling. In addition, rice-fish integration enhances climate resilience and food security. With climate change threatening traditional farming systems, rice-fish integration offers an adaptive solution that promotes resilience and efficiency, reducing dependence on synthetic fertilizers and pesticides, while promoting soil fertility and water quality. This integrated approach shows potential in mitigating the impacts of climate change by optimizing land and water use, and providing diversified income sources for farmers. Additionally, the presence of fish aids in pest control and nutrient cycling, leading to healthier rice crops and improved yields. Therefore, scaling up rice-fish integration in Malawi could contribute to sustainable agriculture, climate resilience, and rural development, warranting further investment and policy support.

CLIMATE ADAPTIVE FEEDING PRACTICES FOR SMALL- AND MEDIUM-SCALE FISH FARMS IN AFRICA

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Climate change is increasingly threatening small- and medium-scale fish farms across Africa, undermining productivity, food security, and livelihoods. Building climate resilience in aquaculture requires fish farmers to adopt innovative feeding strategies and climate-smart production techniques tailored to local conditions. However, the growth of African aquaculture remains hindered by limited access to affordable, high-quality fish feed, with challenges rooted in high costs, poor quality, ingredient shortages, and sustainability issues.

Promoting the use of locally available agricultural by-products, insect meals, and animal by-products as alternative protein sources can reduce reliance on costly imported feeds and unsustainable fishmeal. On-farm feed production using local ingredients, combined with improved feeding practices and adaptive management, further bolsters resilience and productivity. Establishing local feed mills, strengthening distribution networks, and developing community-based feed outlets are practical steps to improve accessibility, especially for smallholder farmers.

Crucially, these nutritional innovations must be integrated with optimized farm management and robust training programs, enabling farmers to implement best practices in response to climate challenges. Climate-smart infrastructure improvements and ecosystem-based solutions, such as agroforestry, offer additional support.

Together, these approaches enhance feed efficiency, lower input costs, and boost fish yields, laying the foundation for sustainable aquaculture growth despite climate variability. Adopting these climate-adaptive strategies is essential to safeguard the future of African aquaculture and the communities that depend on it.

AFFORDABLE, ACCESSIBLE AND SUSTAINABLE FEED – A CORE BOTTLENECK FOR SMALLHOLDERS IN SUB-SAHARAN AFRICA

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In Kenya, about 50,000 small-scale fish farmers cultivate Nile Tilapia (*Oreochromis niloticus*) and African Catfish (*Clarias gariepinus*) in basic fishponds. The fishponds have low and unpredictable productivity, which is highly linked with bottlenecks around feed. Currently, about 70%-80% of production costs of small-scale farmers is needed for purchasing highly priced commercial feed (Table 1), often including protein sources with large climate footprints. The main aim of this article is to evaluate future needs among smallholders for locally produced feed given major trends, and to recommend ways to tackle main bottlenecks of using Black Soldier Fly Larvae (BSFL) (*Hermetia illucens*) as locally produced protein source in feed.

Recently, a new fish production system has been implemented in Kenya referred to as Affordable Recirculation Aquaculture Systems (A-RAS constructions). For A-RAS as well, feed remains a critical bottleneck. Four new A-RAS constructions owned by small-scale farmers, designed to be affordable and accessible and operating on solar energy, provide profits of around €7,000 per year, which for fishponds are about €250. Notably, in both cases, the cost of feed is higher than the profit margins for both systems; about €8,000 and €330, respectively. The existing A-RAS is being upgraded for improvements of water filtration system (A-RAS2). With use of A-RAS by a larger share of smallholders, demand of locally produced feed will increase in future.

Using BSFL as a protein source in feed fish is interesting because organic waste efficiently is converted into high-quality crude protein. Insights include that; 1) chopped dried BSFL is a cost-effective feeding strategy to replace at least up to 20% of the commercial diet for Nile tilapia; 2) use of locally produced BSFL provides an opportunity to increase food security and business development opportunities for low-income groups; 3) the waste issue is tackled by the production of BSFL for protein source in feed, as well as for a high-quality by-product, an organic fertilizer called frass; and 4) BSFL production has low environmental and climate footprints, following the principles of a local circular economy. It is remarkable that BSFL, given all the potentials, is not used to higher extent by smallholders across sub-Saharan Africa as protein source in feed. The reasons why will be presented in this article, as well as solutions to enhancing use of BSFL as feed source in the region given a set of future scenarios of demand.

This research is financed by the Federal Republic of Germany, represented by the Federal Ministry for Economic Cooperation and Development (BMZ), as well as by the Dutch Ministry of Agriculture, Fisheries, Food Security and Nature (LVVN) and Partnership for Water (RVO), the Netherlands.

Table 1. Fish feed a core bottleneck to smallholder fish farmers.

Production variables	Unit	Fishpond	A-RAS	A-RAS2
Surface area	m^2	300	300	300
Water volume	m^3	300	113	113
Cycles	nr/year	1	2	3
Harvest	kg/m^3/cycle	0.69	23	45
Income fish sales	€/year	€ 725	€ 17,816	€ 52,920
Feed cost annual	€/year	€ 326	€ 8,017	€ 23,814
Fingerling costs annual	€/year	€ 135	€ 1,440	€ 4,320
Maintenance	€/year	€ -	€ 1,000	€ 1,400
TOTAL COSTS		€ 461	€ 10,457	€ 29,534
TOTAL INCOME		€ 725	€ 17,816	€ 52,920
PROFIT		€ 263	€ 7,359	€ 23,386

Artemia VALUE CHAINS

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Artemia, or brine shrimp, is a vital input in hatchery-based aquaculture, essential for the early rearing of shrimp, marine fish, and increasingly, ornamental species—supporting the production of over 10 million metric tons of fish and crustaceans. Yet, more than 90% of global Artemia cyst supply still comes from wild sources, mainly hypersaline lakes in the U.S. and Central Asia. This heavy reliance exposes the sector to disruptions in supply, price volatility, and environmental risks.

The World Bank Group PROBLUE study *"A strategic approach to brine shrimp Artemia aquabusiness"* revealed that as global aquaculture expands and demand grows for sustainable, climate-smart feed solutions, the need for reliable Artemia sources is becoming urgent.

It appears that many regions worldwide hold untapped potential for Artemia farming, offering opportunities to enhance hatchery performance, reduce feed imports, create jobs, and support broader blue economy goals.

Proven and scalable Artemia farming systems already operate successfully in China, Vietnam, Thailand, and Bangladesh, and can be adapted to new geographies. Significant market opportunities exist across Asia, Africa, and Latin America, where saline land, rising aquaculture demand, and feed-import dependency converge.

Beyond aquaculture, Artemia biomass has emerging value as a novel livestock feed and a nutrient-rich food source for humans. Expanding production in existing saltworks and artisanal salt systems—particularly in Africa, Asia, and Latin America—could unlock new livelihood opportunities.

Integrating Artemia aquaculture into blue economy and climate-smart agriculture initiatives can drive sustainable development—supporting salt farm revitalization, women-led cooperatives, local employment, and coastal resilience.

THE ROLE OF *Artemia* IN RESILIENT AQUACULTURE

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Artemia, or brine shrimp, produced from commercially available dry embryos (known as cysts), is a vital part of hatchery-based aquaculture. It plays a key role in the early life stages of shrimp and fish, supporting the production of over 10 million metric tons of aquaculture products each year.

Despite its critical role, more than 90% of the global supply of Artemia cysts still comes from wild sources—mainly hypersaline lakes in the United States and Central Asia. This heavy reliance makes the aquaculture industry vulnerable to supply disruptions, price fluctuations, and environmental concerns.

The recent study by the World Bank Group's PROBLUE program, "A Strategic Approach to Brine Shrimp Artemia Aquabusiness," underscores the urgent need for reliable, sustainable, and climate-resilient Artemia production to keep pace with the growing global demand for aquaculture.

The study highlights significant untapped potential for Artemia farming—both for live biomass and cyst production—in various regions around the world. Expanding Artemia aquaculture can improve hatchery performance, reduce dependence on imported feed, create jobs, and advance broader blue economy goals. Successful and scalable farming systems already in place in China, Vietnam, Thailand, and Bangladesh provide practical models that can be adapted to other regions, helping make the industry more resilient as wild cyst sources decline.

CRUCIAL ROLE OF *Artemia* IN SOLAR SALT PRODUCTION: OPPORTUNITY FOR NEW INTEGRATED *Artemia*-SALT FARMING BUSINESS MODEL?

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Solar saltworks are facilities where NaCl salt is produced through the natural evaporation of seawater or brine using sunlight and wind. These saltworks typically consist of large, shallow ponds or pans that allow water to evaporate slowly, leaving behind crystallized salt. This method is energy-efficient and environmentally friendly, as it relies on natural solar energy rather than industrial processes. Solar saltworks are commonly found in warm, arid coastal regions where evaporation rates are high.

Saltworks are not just to be considered as a kind of factory for salt production, but also as an ecosystem. Appropriate management ensures that each area develops a specific and interactive flora and fauna, to avoid hydrobiological imbalances that could negatively affect salt production in terms of salt quantity and/or quality.

Phytoplankton in saltworks often form monocultures, influenced by salinity and other conditions, which impact pond color and evaporation rates. High algae density boosts evaporation by absorbing more sunlight. In coastal areas with highly oligotrophic intake waters, additional fertilization of evaporation ponds is necessary to promote adequate algal blooms.

Artemia, the main zooplankton in saltworks, plays a crucial role in maintaining balance. It controls algae populations through grazing, preventing overgrowth that could hinder salt quality. Excess algae, especially in high salinity, can delay gypsum precipitation and reduce salt purity.

When brine shrimp die, their decomposing bodies provide a nutrient-rich substrate for halophilic microorganisms. These microbes produce red pigments that give the water its characteristic coloration, which enhances heat absorption and boosts evaporation. Additionally, their activity reduces water viscosity, promoting the formation of larger salt crystals and improving overall salt quality.

Effective Artemia management is often essential for maintaining optimal salt production conditions. This includes controlling excessive algal blooms by inoculating ponds with nauplii hatched from commercially available cysts or by transplanting Artemia biomass within the farm or from nearby saltworks.

It is understandable that the primary commercial focus of solar salt farmers is the production of high-quality salt, with Artemia often regarded as a secondary byproduct. Moreover, the conditions within salt farms are typically not optimized for Artemia cultivation. However, adjacent areas could be developed specifically for efficient Artemia biomass and/or cyst production. By managing brine inputs into these Artemia ponds and directing brine outputs back into the main evaporation system, valuable opportunities for integrated business models and enhanced profitability could emerge.

A DISCUSSION ON THE IMPACT OF THE PARASITE *Myxobolus spp* A WIDELY PREVALENT AND UNDER-ESTMATED RISK TO TILAPIA FARMERS

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Myxosporean parasites, including species within the *Myxobolus* genus, are increasingly recognized as significant contributors to systemic disease in farmed fish, particularly in intensive aquaculture systems. This discussion presents comprehensive histopathological evidence from hatchery and grow-out operations indicating widespread Myxosporea infections. Early-stage infections were consistently observed in swim-up fry and fingerlings, often localized to the gill and skin tissue but with rapid progression into systemic involvement, including the liver, kidney, spleen, muscle, and gonads. Key lesions included granulomatous inflammation, epithelial lifting, branchitis, interstitial oedema, and necrotizing cyst rupture, contributing to compromised organ function. While inflammatory responses were often minimal, pressure atrophy and tissue degeneration due to parasitic expansion were evident. Notably, some cases revealed co-morbidities with intracellular bacteria and secondary fungal infections, highlighting the potential for complex disease presentations in immunocompromised fish.

Environmental stressors—particularly poor water quality, physical handling injuries, and overcrowding—were strongly associated with increased severity and prevalence of Myxosporea infections. These stressors are likely to impair immune responses and facilitate parasite proliferation. The parasite's presence internally, rather than being limited to external irritation, underscores the need for a paradigm shift in farm perception and management of parasitic diseases.

This discussion aims to equip tilapia farmers with the diagnostic awareness and practical tools to mitigate the impact of systemic myxosporeaniasis and reduce production losses. Routine health monitoring through targeted sampling and histopathology, as well as training farm staff in early detection, should form part of an integrated health strategy.

MASS FISH MORTALITIES ON LAKE VICTORIA: AN ESCALATING AGE-OLD PHENOMENON MAGNIFIED BY AQUACULTURE?

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Mass fish mortalities have become increasingly prevalent on Lake Victoria, especially in the past five years, even affecting well-sited fish cages and resulting in significant losses (Fig 2). This phenomenon, often attributed to periodic water quality deterioration caused by natural seasonal mixing events, is not new and has been observed by indigenous fishermen on some lakes for generations. In Uganda, it is known as "*Kaliro*," meaning "small fire," likely due to the half-burnt appearance of the dead fish, which are rancid, with milky eyes and dull whitish skin. This case report examines the intrinsic and extrinsic factors contributing to mass fish mortalities and the water quality dynamics of shallow tropical freshwater lakes (Fig. 1).

Given the recurrent nature of this natural calamity and its impact on aquaculture in Lake Victoria, we propose strategic measures to mitigate its effects. These include strategic fish cage siting involving proper zoning and spatial planning, enforcement of appropriate cage culture management practices (fallowing, daily site-based water quality measurement), development of stakeholder and citizen scientist networks, IoT and AI early warning systems, effective legislation, and advocating for sustainable aquaculture practices such as Integrated Multi-trophic Aquaculture (IMTA). Addressing these challenges requires a comprehensive, transboundary approach to ensure the sustainable development of aquaculture in Lake Victoria.

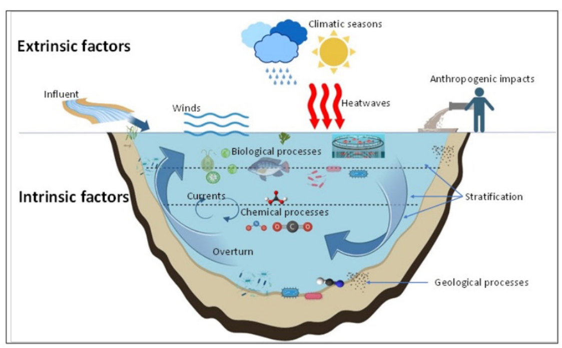

Fig 1. Extrinsic and intrinsic factors that influence water quality in a shallow tropical freshwater lake system.

Fig 2. Incidents of mass fish mortalities due to "*Kaliro*" on Lake Victoria recorded at fish cage sites (A, B, D, E, F) and in the wild (C). Images D and E depict the disposal of dead fish by burying in Uganda after false suspicions of disease.

INTERACTIVE EFFECT OF WATER TEMPERATURE AND NITRATE FERTILIZERS ON GROWTH, SURVIVAL, AND HATCHING SUCCESS OF EGGS, EMBRYOS AND LARVAE OF AFRICAN CATFISH *Clarias gariepinus,* BURCHELL 1822)

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The study assessed the interactive effect of water temperature and nitrate fertilizers on growth, survival, and hatching success of eggs, embryos and larvae of African catfish *Clarias gariepinus*. One hundred fertilized eggs and 30 hatched larvae of *C. gariepinus* were incubated in glass flasks (1000ml) filled to 800ml mark with groundwater containing one of the five concentrations of inorganic nitrate (control, 5, 10, 15 and 20 mg NO_3-N/L) levels. These flasks were randomly placed in three water bath each set at 25, 28, and 31ºC temperature levels in triplicates. Data were collected for ten days. The results showed a significant interaction between the temperature and nitrate on hatching rate, incubation period, hatching period for the egg and embryonic stages and the rate of growth and survival for the larval stage. *C. gariepinus* larvae were resilient to nitrate up to 10mg NO_3-N/L at all incubation temperatures (28 to 31°C). The study concluded that the interaction between temperature and nitrate fertilizers had negative effects on the growth, survival and hatching success of *C. gariepinus* eggs, embryos and larvae. It is therefore recommended that alternative sources of nitrates such as organic farming should be encouraged in Agricultural fields other than artificial fertilizers.

SALINE AQUAPONICS SYSTEM ADDRESSES FOOD INSECURITY BY UTILIZING SALINE WATER AND SALT-TOLERANT SPECIES, REDUCING RELIANCE ON FRESHWATER RESOURCES

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Currently, many rural economies are locked in subsistence farming and are vulnerable to food insecurity due to lack of access to water, technical know-how and feasible revenue streams, further aggravated by unsustainable farming practices and resulting in migration from rural areas to cities. Climate change negatively affects agricultural production in water-scarce regions of Africa, which makes water use efficiency one of the key factors for agricultural and rural livelihoods. Agriculture is still the most important economic sector in rural Africa and pathways of transition to a circular bioeconomy bears significant potential for socio-economic and environmental sustainability of rural communities in the long term. Revenue diversification pathways in Africa through bio-based and circular agricultural innovations (DIVAGRI) is an EU Horizon2020 funded research projects which includes 39 direct partners. The DIVAGRI consortium (https://divagri.org) has identified a range of major challenges in its target regions and identified solutions to address them within the scope of the project.

The Solar Desalination Greenhouse (SDGD) is a technology that transforms saltwater into freshwater, which can then be used for irrigation or mineralized for drinking. This desalination process is facilitated by halophytes, plants that have adapted to grow in saline conditions. As these plants grow, they humidify the air within the greenhouse. The SDGH then uses passive and active dehumidification to produce freshwater from this humid air, without the need for energy. The SDGH also offers additional benefits such as the production of high-value halophytes and sea salt. It's a flexible system with moderate installation and operating costs, and it can utilize renewable energy sources like solar or geothermal power.

At the Welgevallen Experimental Farm in Stellenbosch, the University of Stellenbosch has adapted the SDGH to include aquaponics. The system has two water tanks with 1 000 Mozambique Tilapia (*Oreochromis mossambicus)* that are linked to 8 raised media beds, deepwater culture and an NFT system. The tilapias that are fed daily provide nutrients for the halophyte plants called Salicornia (*Salicornia meyeriana)*. The water circulates between the plants and the fish in the tanks. The Salicornia grow in the brackish saline water at 20 ‰ (ppt), extracting the salt and producing water vapour that condenses on the sides of the greenhouse. The Salicornia plants can be harvested to produce a natural salt and are also used for fodder for livestock. The water can be harvested for drinking or other agricultural purposes.

OFF-THE-GRID BIO-FLOC AQUACULTURE EMPOWERMENT PROJECT

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The off-grid Aquaculture Bio-floc Community Empowerment Project is an innovative approach to sustainable aquaculture, combining renewable energy sources, eco-friendly practices, and community involvement. The goal is to create a self-sustaining system for fish farming using bio-floc technology in an off-the-grid environment, typically in rural or remote areas with limited access to centralized power or infrastructure. Bio-floc is a process where microorganisms, such as bacteria, algae, and fungi, naturally grow in the water and create a network of particles that can be used as food for fish. This system improves water quality, reduces the need for water exchange, and supports a more efficient fish farming process.

Benefits:
• Reduced need for large water volumes or frequent water changes.
• Cost-effective and sustainable since it uses waste as a resource.
• Encourages nutrient recycling and reduces dependence on external feed sources.

Off-the-grid Energy Solutions:
• Renewable Energy: Since the project is off-the-grid, renewable energy systems such as solar, is used to provide electricity to run pumps, aerators, and other equipment.
• Solar Panels: Solar power is often the most feasible option for off-the-grid aquaculture systems, providing energy to run water filtration, oxygenation, and monitoring systems.
• Battery Storage: To ensure a stable power supply, energy is stored in batteries or other storage systems, enabling the operation of critical systems even during cloudy days or at night.

Community Involvement & Education:
• Training Programs: Education and capacity building for local communities are crucial. Training should focus on sustainable aquaculture practices, renewable energy technologies, and bio-floc management.
• Community Collaboration: In an off-the-grid setting, it’s important to build a sense of ownership within the community. Collaboration could include local farmers, entrepreneurs, and even schools to foster long-term success.
• Job Creation: The project can provide jobs in fish farming, renewable energy maintenance, system operation, and monitoring, supporting the local economy and improving food security.

CLIMATE INFORMATION SYSTEMS (CIS) FOR AQUACULTURE: DEVELOPMENT OF A TEMPERATURE-BASED, EARLY-WARNING ALERT SYSTEM FOR FISH FARMERS IN ZAMBIA AND MALAWI

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Zambia and Malawi are rated as two of the most vulnerable countries to climate change, while smallholder tilapia farmers lack the expertise and resources to implement mitigation strategies in response to adverse weather conditions. Among climate-driven environmental stressors, such as water supply and temperature variability, temperature can cause production loss and poor physiological performance of tilapia in the short term. Pond temperature fluctuations beyond favourable production conditions need to be foreseen and managed in advance. Through WorldFish, an air-water temperature relationship algorithm for pond water temperature forecasting was developed to be integrated with the iSAT data hub and an early temperature warning decision tree matrix. The decision tree matrix will be developed into a dashboard based on input data and water-quality parameter thresholds for critical scenarios for tilapia and catfish. To mitigate the impact of high-risk (24 and 32 °C for minimum and maximum temperatures, respectively) and emergency (12 and 40 °C) scenarios on cultured stock, a color-coded alarm corresponding with a specific action protocol for pond temperature regulation is activated once predicted pond temperatures approach temperature thresholds. In each case, the messages include information about the current temperature, predictions, the impact of temperature on fish health, monitoring parameters, monitoring frequency, and mitigation steps. The prediction tool's early warning system is based on pond temperature thresholds derived from mean pond temperatures. It is however important to note that normal pond temperatures between 12 and 18 °C are not optimal for tilapia growth and feed conversion efficiency. A temperature-based early-warning alert system can significantly enhance the resilience and productivity of fish farming in Zambia and Malawi by providing farmers with timely information to adapt to environmental challenges. This system would not only help in managing risks associated with extreme temperatures but also contribute to the overall sustainability and growth of the aquaculture sector in these regions. Future work will focus on the development of priority low-cost pond monitoring equipment for temperature, oxygen levels, and pH, that can store data in an online database. Additionally, hydrological data for surface waters and pond water replacement rates needs to be integrated.

SMARTER STORAGE: HOW TO SAFELY INCREASE THE SHELF-LIFE OF FRESH FISH IN AFRICA

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Fish is a lean and highly nutritious food source that contains high amounts of vitamins, proteins, minerals, little or no saturated fat and is low in carbohydrates. However, fish is highly perishable, facing rapid deterioration in freshness that poses spoilage risks and potential health concerns without proper preservation. Fish spoilage is mainly due to enzymatic activity, microbial growth and lipid oxidation which result in the loss of positive sensory attributes. Globally, an estimate of 10 - 12 million tons of fish are lost per year, accounting for 10 % of total fish production from capture fisheries and aquaculture. Fish post-harvest losses in Sub-Saharan African counties are higher than those in other regions, with fisheries in these countries valued at approximately 24 billion USD, 1,26 % of the GDP of all the African nations and 6 % of agriculture GDP. The majority of fish post-harvest losses in Sub-Saharan African countries occur during production (39 %), handling (36 %), distribution (13 %), processing (7 %) and consumption (5 %). The key contributing factors to these losses include long hauling times, spoilage, species and size discrimination, operational losses, animal predation, poor handling practices, lengthy duration of fishing cycle, failure to use ice, lack of storage facilities, lack of transportation and insect infestation. Fish post-harvest losses amount one third of total production and financial losses of 2 to 5 billion USD annually in Sub-Saharan African countries.

This study aims to investigate the potential of using interventions from Savour Solutions™ , to extend the shelf-life of fresh Tilapia (*Oreochromis niloticus*). These products contain lactic acid and inorganic salts. Fresh tilapia sized 100 g to 250 g will be humanely euthanised and filleted before being divided into three groups: Control group and two test groups (Treated 1 and Treated 2). Fish will be dipped in the solutions prior to filleting and after evisceration. The fillets will be sprayed with the solutions before packaging. Packed fish will be kept at 4 °C ±2 °C for the duration of 14 days. A fresh sealed sample from each group will be tested daily for the duration of the trial. The tests will include total aerobic viable count (TVC), lactic acid bacteria (LAB) count and total coliform count to assess microbial growth and spoilage. The results of this study will determine the effectiveness of the Savour Solutions™ interventions in prolonging the freshness and safety of fresh fish, thereby offering extended shelf-life to fresh fish, that will result in a reduction in post-harvest losses in fish production.

IGNITING A MAJOR FOOD INDUSTRY IN NAMIBIA AND SOUTH AFRICA WITH NORWEGIAN AQUACULTURE TECHNOLOGY ABSTRACT

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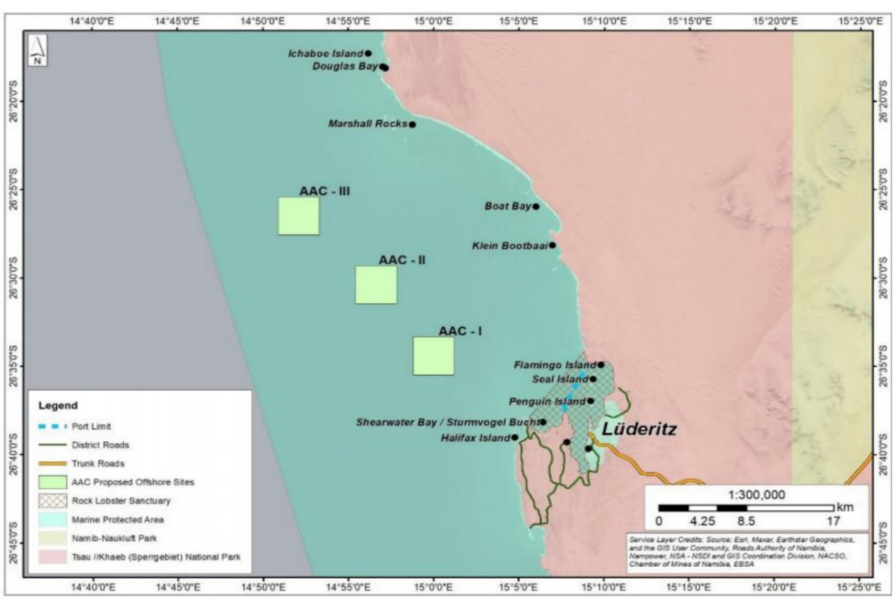
The African Aquaculture Company (AAC) is spearheading a Norwegian initiative to establish salmon farming in the Benguela Current, leveraging optimal cold-water conditions (10-16°C) and Norwegian aquaculture technology. With a production license for 51,000 tonnes across three sites near Lüderitz, Namibia, AAC aims to ignite a major food industry in Southern Africa. The project includes smolt production in Fizantakraal, South Africa, with a capacity of 1.5 million smolt, and plans for scaling operations to full production by 2034.

Key investment highlights include low start-up costs, high profitability, and positive EBITDA projected within three years. The initiative addresses global demand for Atlantic salmon, growing at 6% annually, while reducing transport costs by replacing air freight from Europe. AAC is committed to environmental, social, and governance (ESG) principles, focusing on fish welfare, local job creation, environmental monitoring, and sustainable feed production.

The project is expected to generate significant export revenue (EUR 400-450 million annually) and create substantial employment opportunities, supported by training programs and collaboration with universities. AAC invites Namibian and international investors to participate as co-owners, with Series B funding open until Q4 2025.

The initiative builds on proven biological feasibility, with salmon previously farmed in the Benguela Current. Risks such as wave conditions, feed registration, and operational planning are being addressed. AAC's legal structure includes subsidiaries in Namibia and South Africa, ensuring streamlined operations and distribution. This ambitious project aims to transform Southern Africa's aquaculture landscape while contributing to global food security.



DOES OXYGEN LEVELS BELOW THE NORMOXIC CONDITIONS HAVE A SIGNIFICANT EFFECT ON THE AIR BREATHING AND SWIMMING BEHAVIOUR OF AFRICAN CATFISH *Clarias gariepinus* JUVENILES?

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Oxygen availability is a critical environmental factor influencing the physiology and behaviour of aquatic organisms. This study investigated the effects of chronic exposure to varying oxygen levels on the respiratory and locomotor behaviours of African catfish (*Clarias gariepinus*) juveniles (mean body mass: 92.0 ± 6.6 g).

Three groups of fish (n = 8 per treatment) were acclimated for 30 days to normoxic (6 mgL^{-1}), moderately hypoxic (3 mgL^{-1}), and extremely hypoxic conditions (<1 mgL^{-1}). During acclimatization, the fish were hand fed three times daily at 3% of their body with a commercial feed. Following acclimation, air-breathing frequency, gill ventilation rates, and general swimming activity were assessed. Results showed that reduced oxygen levels elicited slight changes in air-breathing frequencies which were not statistically significant across treatments. The mean air-breathing frequencies ranged from a highest of 1.11±0.24 breaths min^{-1} in the normoxia group, followed by 0.90 ± 0.21 and 0.91 ± 0.18 breaths min^{-1} in the moderate hypoxia and extreme hypoxia groups respectively. Gill ventilation and swimming behaviours remained largely unaffected. These findings suggest that *C. gariepinus* juveniles exhibit a degree of behavioural resilience to chronic hypoxia, with limited adjustments in respiratory behaviour. This highlights the species' adaptive potential to fluctuating oxygen environments, which is relevant for aquaculture systems and natural habitats increasingly affected by deoxygenation.

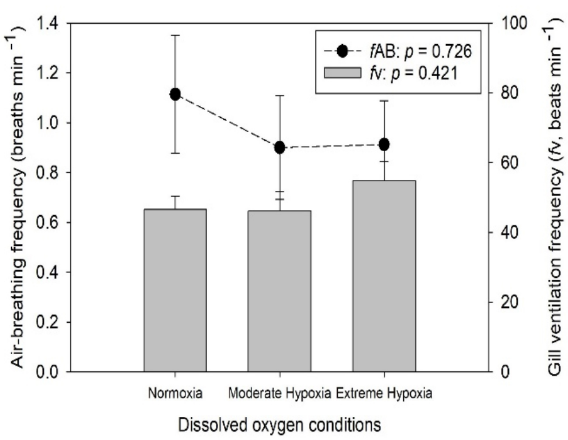

Figure 1: Air-breathing frequencies of *C. gariepinus* (breaths min^{-1}) and gill ventilation frequency of the dissolved oxygen concentration groups. Each bar represents the mean ± SEM of each level (n= 8).

BACTERIOPHAGE ACTION AGAINST TILAPIA FISH *Aeromonas* IN AQUARIUM TANKS IN UGANDA

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Aeromonas is one of the most virulent fish pathogens known. *Aeromonas hydrophila* causes a fish disease known as "Aeromonas or Hemorrhagic Septicemia or Motile Aeromonas Septicemia or Ulcer Disease or Red-Sore Disease". Management involves both prophylactic and therapeutic use of antibiotics. Unfortunately, the indiscriminate use of antimicrobial agents has led to the development of resistant strains of bacteria. The need for alternative strategies other than antibiotics has stimulated research into lytic bacteriophages because of the lower chance of bacteria developing resistance. This study assessed the effect of using bacteriophages on *Aeromonas hydrophila* in the treatment of tilapia fish Aeromonasis.

The host was resuscitated and reconfirmed using biochemical tests and genetic profiling. The profiled bacteriophage was bulked up and enumerated using the overlay agar method. Bacteriophage stability in tank water for Ph and temperature levels was established. Fish fingerlings of an average weight of 5 gms were acclimatized, put in aquarium glass water tanks and separated into test and control subjects. Test subjects were divided into two groups, one inoculated with bacteria, stressed through delayed feeding and bacteriophages added to the tanks. while the second test group had bacteriophage added without stress. The control groups were not inoculated with either bacteria or phages.

Bacteriophages exhibited stability at both pH 6-9 in tank water. The bathing method was found to be effective for fish challenge and phage application. Stress influenced fish disease in the tanks. A multiplicity of infection of 0.01, 0.1, and 1 showed efficacy on clearing with no differences, while 10 and 100 had outstanding results. Bacteriophage dissociation took around 14 days from the treatment day.

The survival curves plotted using GraphPad Prism version 5 using the Log-rank (Mantel-Cox) test revealed a significant difference in the survival of fish (Chi square = 20.92, df =2 and P value <0.0001 in both test and control groups. The non-parametric test for differences in the survival curves, using the Gehan-Breslow-Wilcoxon test, revealed a significant difference between the curves ($\chi^2 = 19.67$, df = 2, $P < 0.0001$).

Use of a single phage isolate showed control of *Aeromonas hydrophila* infection in water tanks. Direct administration of phages to tank water is an effective route for both phage application and bacterial challenge. Future studies were recommended to establish phage stability in pond water and the need to test the survival of fish in pond water infested with *Aeromonas hydrophila* using cocktail phage prepared from the three profiled isolates.

UNLOCKING PROTEIN DIGESTIBILITY WITH ECONOMIX TO REDUCE FEED COSTS IN AQUACULTURE

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Fishmeal (FM) is the primary protein source in aquaculture feeds, but its price has risen due to overfishing and climate change reducing supply. Alternatives like plant-based proteins, insect meals, and single-cell proteins are being explored, but their lower digestibility can hinder growth and feed efficiency. Enhancing their digestibility is key to meeting the nutritional needs of farmed species.

Economix is a plant-based feed additive produced by TECHNA FRANCE NUTRITION (Couëron, France) that aims at enhancing protein digestibility. It offers a promising solution for reducing FM use and substituting it with more affordable plant proteins.

A digestibility trial was held at Sparos, Portugal, to evaluate the effect of Economix on apparent digestibility coefficients (ADC) of nutrients in European seabass (*Dicentrarchus labrax*). The trial comprised two experimental diets, both containing 0.02% yttrium oxide as an inert digestibility marker.

- Control diet: 30% FM
- Economix diet: 28% FM + 0.2% Economix

The Economix diet reduces FM by 2% compared to the Control diet, replacing it with plant proteins (soybean meal, wheat) and 0.2% Economix additive. This reformulation achieves a cost reduction of -1.78% compared to the Control diet.

Each diet was tested in triplicate groups of 13 fish (mean body weight: 73 ± 5 g), maintained in 60 L tanks at a constant water temperature of 20.0 ± 0.43°C. Feces were collected in tanks equipped with a fecal decantation column (Guelph system).

The results showed that the inclusion of 0.2% Economix significantly improved the amino acids digestibility of 13 out of the 17 analyzed amino acids, including lysine, methionine, and threonine ($p < 0.05$). This trial also indicated numerically higher values, although not statistically significant, for protein, fat and energy digestibility.

To conclude, Economix, with its ability to enhance amino acid digestibility, offers a viable solution by enabling the reduction of fishmeal and the incorporation of cheaper, more sustainable protein sources, while maintaining optimal performance in fish and shrimp.

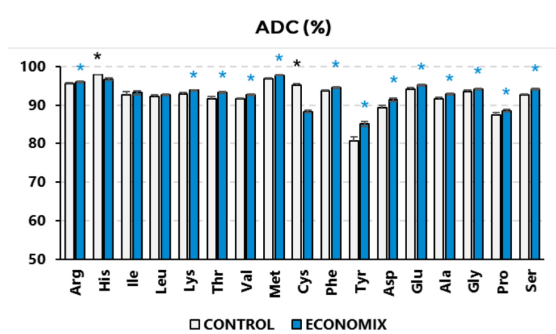

Figure 1. Effect of Economix on amino acid digestibility of European seabass *Dicentrarchus labrax* at Sparos, Portugal

EFFECTS OF REPLACEMENT OF FISH MEAL WITH A MIXTURE OF COWPEAS *Vigna unguiculata* AND AMARANTH *Amaranthus cruentus* IN LABEO VICTORIA *Labeo victorianus* CULTURE

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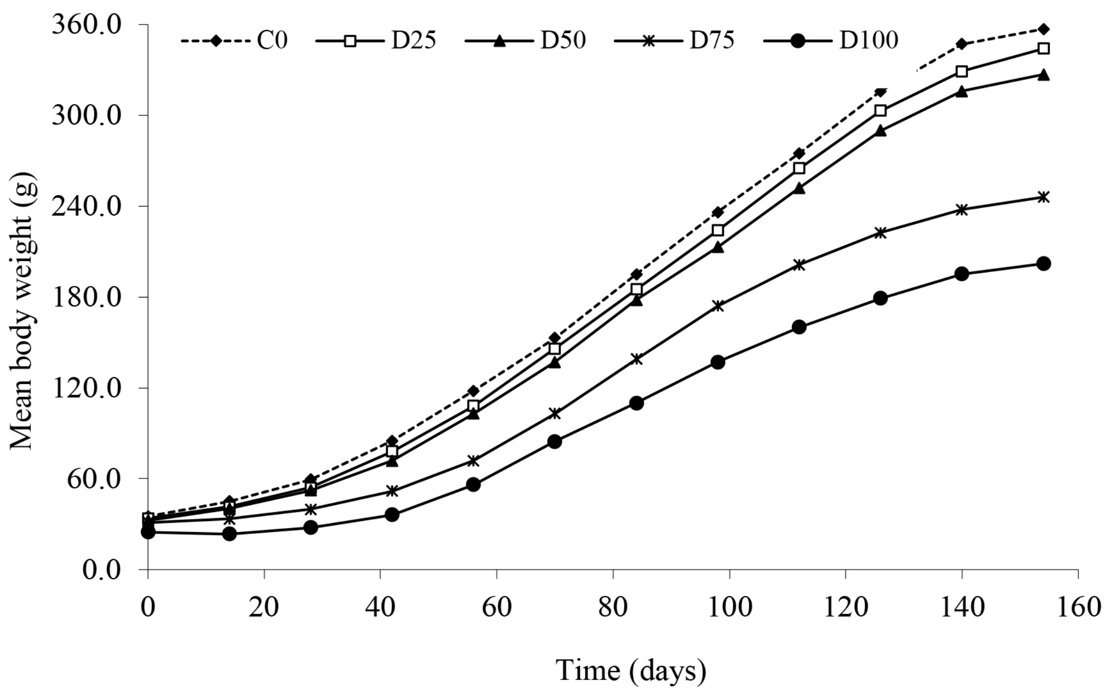
The study evaluated the suitability of replacing fish meal with a mixture of two plant proteins: cowpeas (*Vigna unguiculata*) and *Amaranthus cruentus* as a protein source in the diet of three weeks old *Labeo victorianus* on growth performance, nutrient utilization and carcass proximate composition. Fishmeal was replaced with the mixed vegetables at a ratio of 25%, 50%, 75% and 100% and the substitution effects compared with control diet containing fish meal as the sole protein source. The five dietary treatments were tested in triplicate in static flow through tanks for 90 days. The fish were fed four times a day at 4% body weight. After 160 days of feeding, growth, nutrient utilization and FCR in fish fed at 25% and 50% *Vigna unguiculata*) and *Amaranthus cruentus* were better than those fed 75% and 100% *Vigna unguiculata*) and *Amaranthus cruentus* but not significantly different from those fed with fish meals diets alone (F = 17.002, P = 0.002). Growth reduction, increased FCR and reduced nutrient utilization occurred with increasing plant inclusion in the diet beyond 50% inclusion levels. Thus it is possible to replace up to 50% of fish meal with a mixture of *V.unguiculata* and *Amaranthus cruentus in* the diets of *L. victorianus*. This will reduce the cost of production as fish meal is increasingly becoming expensive as its demand outweighs its supply.

This finding lends credence in the continued research into areas of utilization of alternative plant proteins sources in place of fishmeal based feeds as protein sources in improving aquaculture.



AQUATIC VETERINARY MEDICINE IN AFRICA: FINDING CREATIVE WAYS TO ADDRESS THE CHALLENGES OF AQUATIC HEALTH MANAGEMENT IN RESOURCE CONSTRAINED ECONOMIES

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Aquatic veterinary medicine and health management is an emerging field of Veterinary Science, with global veterinary faculty undergraduate curricula only beginning to include modules in recent years. With an explosive growth over 500% in global aquaculture production over the last twenty years, increased focus on intensive production of fish to address food security deficits, and concomitant emergence of disease, the mismatch between need for aquatic veterinary support and diagnostic services, and existing capacity is a serious problem. And we see this situation playing out most glaringly in developing regions of the world, where veterinary and diagnostic capacity is already poor to non-existent. Africa has the fastest growing aquaculture sector globally but not enough veterinarians and animal health technicians to support it. In addition, South Africa has one of the largest relative koi and ornamental pet fish populations globally and also not enough vets to support this sector. The result of this deficit is the emergence of lay-persons practicing veterinary medicine, uncontrolled disease management, misuse of antimicrobials, poor farmer support, and poorly informed regulatory policies.

The Aquatic Health Unit at the Faculty of Veterinary Science, University of Pretoria was established in response to the growing demand for Aquatic Animal Health services by South Africa's commercial aquaculture and ornamental sectors. The vision of the unit is to stand as a leader of aquaculture and aquatic health research and veterinary medicine in Africa, and through research, training and service, contribute towards development of public health and infectious disease control policy, improved aquatic health and welfare, and thereby improved productivity and sustainability of African aquaculture and aquatic health.

This presentation will focus on how the facility has structured its development in a step- by- step but dynamic and fluid manner to attempt to offer practical upskilling to both undergraduate and qualified veterinarians, para-veterinarians and farmers in a manner that meets industry needs and promotes global collaboration.

WHY WORRY ABOUT FISH HEALTH IN AQUACULTURE?

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It is sometimes hard to appreciate the devastating economic impact that disease can have within an aquatic system, be it a large commercial farm or small aquarium, and it is often an aspect of aquatic animal management that is overlooked or underestimated.

With real case study examples of commonly encountered aquatic health challenges and pathogens seen within the aquaculture sector in South Africa, this presentation discusses the basic underlying mechanisms and pathogenesis that often play out into both large- scale mass morbidity or mortality events, but more importantly the chronic impact upon production, and concomitant economic implications to the farmer.

BIOSECURITY CERTIFICATION FOR DEVELOPING REGIONS: A COLLABORATIVE VETERINARY- INDUSTRY APPROACH TO SUPPORTING A HEALTHY AQUACULTURE SECTOR

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Disease outbreaks in aquaculture systems can be devastating, especially for those who are not equipped to deal with them. Small aquaculture enterprises in Africa don't have the resources to address biosecurity like their large global counterparts, with high level technology, biosecurity plans and large- scale disease surveillance. Lack of veterinary and diagnostic capacity in Africa further exacerbates the situation. A need exists for a health and biosecurity plan that fits the realities of African aquaculture and the farmers' pocket. To this end, in conjunction with the Tilapia Aquaculture Association of South Africa, TAASA, a tiered farm flagging biosecurity plan was designed. This plan not only minimizes disease introduction risk and outbreaks, but also helps farmers increase their profit margins and the marketability of their products, by identifying underlying stressors that impact productivity, growth and health. With stress and subclinical disease found to play a significant role in farm outputs in South Africa, the biosecurity plan focuses strongly on identifying farming and husbandry practices affecting health like water quality, system design and filtration, nutritional impact, disease management and lack of biosecurity. In addition to biosecurity and disease surveillance, strong emphasis is placed on training and developing the farm team to better understand and manage health and biosecurity on the unit.

To provide accessibility to small scale farmers, the plan provides three farm flag status awards, each with varying levels of input and cost, but with the goal to allow affordable entry and development of start- up farmers. All three levels build upon each another, increasing in difficulty and qualifying requirements – such as training and rigorous screening – moving from Yellow Flag to Green Flag and, finally, at the highest level, Blue Flag farms.

This certification system now serves as an industry standard for the tilapia sector in South Africa and has achieved global recognition as a novel certification standard.

EVALUATION OF BODY COMPOSITION AND SAPONIN CONTENT IN MUSCLES OF *Oreochromis shiranus* FED ON *Acacia nilotica* PODS EXTRACT

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Botanical extract of *Acacia nilotica* pods have antifertility effects on Fish after administration for specific time. However, limited research has been done on evaluation of body composition and saponin content in muscles of *Oreochromis shiranus* fed on *Acacia nilotica* Pods extract, were by the estimation of the actual quantity of Saponins us secondary metabolites, anti-nutrition factor and the influence on organoleptic analysis to further consumption from human being.. Because of that, experimental trial was conducted at Bunda fish farm in order to evaluate body composition and safety of *Oreochromis shiranus (O. shiranus)* fed on *A. nilotica* pods extract. Male *O. shiranus* with mean weight of 100±0.09g was stocked at rate of 15 fish/tank, for 18 weeks. The treatments were completely randomly assigned in triplicate in the experimental units (Control Feed 0gkg^{-1}of the inclusion level of *A. nilotica* extract and Feed with *A. nilotica* extract at inclusion level of 15g/kg). The data was transferred from excel to R statistical software, for analysis, were T-Tests for independent sample and one way Analysis of Variance (ANOVA), at statistical significance level set at P<(0.05), after that, Tukey test was performed. According to the standard methods, the results indicated that the *Acacia nilotica* pod extract have Phytochemical such as Saponins, Tannins, Terpenoids, Antraquinones and Anthocyanins; about the residual bioactive compound (Saponins) there were statistical difference at P<(0.05); at termination point the Saponins(%) was (5.025±0.591) and it was reducing up to (1.761±0.030) it in 4 weeks period after termination the administration of the *A. nilotica* in the fed. Body Composition there were statistical difference at P<(0.05), Protein (70.125±0.554)- (53.330±3.095), Ash (24.389±1.411)- (16.131±0.617) termination point was superior than the Control. In terms of Fat there were statistical difference at P<(0.05), however control presented more than the termination point (14.265±0.0142)-(9.198±0.823), on the organoleptic there were not statistically significantly different from zero at P>(0.05). The results of this study suggest that at the inclusion level of the 15 g/kg *O. shiranus* can be safer for consumption in 2 weeks after termination of the extract administration, since the amount of crude saponins is lower than the toxic level.

STRATEGIC ZONING AND SPATIAL PLANNING FOR SUSTAINABLE AQUACULTURE DEVELOPMENT IN EAST AFRICA

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The EDF11 funded TRUEFISH project is a five-year development project coordinated jointly by the Lake Victoria Fisheries Organisation (LVFO), Landell Mills, WorldFish and the Food and Agriculture Organisation of the United Nations (FAO). The overall objective is to contribute to the development of a competitive, gender-equitable and sustainable commercial aquaculture sector to support economic development and sustainable management of natural resources in the Lake Victoria Basin. Sustainable development of cage aquaculture in a water body such as Lake Victoria requires careful spatial planning and management strategies to ensure that aquaculture is sited in correct and appropriate locations for optimisation of environment and production sustainability, and for consideration of other users of the water body. Such spatial planning should be accomplished across whole-lake, national and local scales, and be agreed and implemented by local and national authorities and user groups.

The results and outcomes presented here will show how the development of new spatial management plans in Lake Victoria are underpinned through GIS-based site selection models for aquaculture, considering environment, production, social, and space-conflicts issues, to designate two strategic aquaculture zones for each country area within Lake Victoria. Each zone was assessed for its aquaculture carrying capacity using established modelling approaches, based on water volume exchange and the predicted effects of nutrients from all sources on the environment (OECD, 1982). An Aquaculture Management Area (AMA) was designated for each zone. Placement, layout and size of cage farms within the AMA were modelled using the dispersion footprint and impacts of released wastes. This is integrated with a defined environmental monitoring and measurement plan to ensure environmental compliance of cage farms in the future; Figure 1.

The outcomes from this study, along with aquaculture situation analyses for each country, were used for the development of an Adaptive Management Plan for aquaculture development in Lake Victoria and a Regulatory and Institutional Framework for strategic aquaculture zoning and spatial management within each national area for the Lake. Each will be presented here for consideration and discussion, along with an East African Community dissemination plan for wider communication and stakeholder engagement.

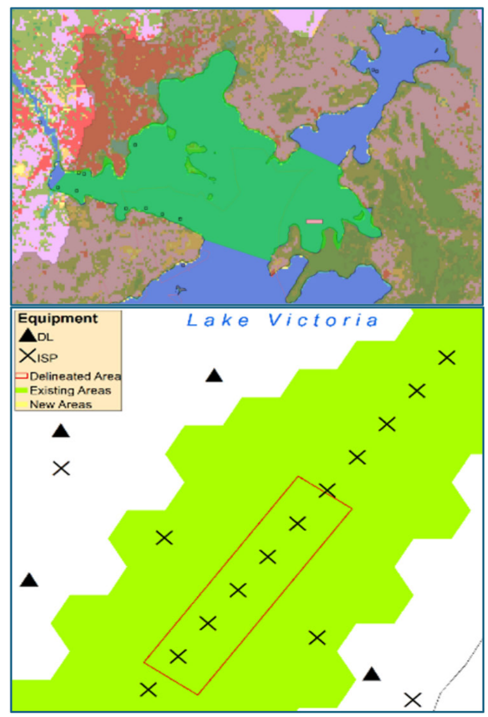

Fig. 1 A defined aquaculture zone near Jinja in Uganda containing an AMA (top), and recommended sampling design

MY FISH ARE DYING... “SO WORTH”?

Dr. Jeff Terhune

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Stock is money! Fish death is money lost. The speaker will lead a session covering the impact of disease and mortality on FCR, including a demonstration on how to calculate the impact of increased mortality. Dr. Terhune will discuss the required support infrastructure needed to improve solution delivery time. He will highlight some of the management impacts from the ISKNV outbreak in Ghana, including impacts on broodstock, pond management, and energy use.

The WISHH team will facilitate a discussion with the audience about biosecurity implementation.

PROFITABILITY OF PILOT CAGE FISH CULTURE IN SMALL RESERVOIRS IN NORTHERN GHANA

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Small reservoirs could play a significant role in the context of aquatic food systems. Cage fish culture in small reservoirs could be a viable option for enhancing fish production, improving food security, and boosting rural livelihoods. A pilot study was conducted in North East region of Ghana to assess the potential of small reservoirs to produce fish for income and improve food security. The study assessed the profitability of two community based pilot cage fish farming in two reservoirs in the Northeast region by analyzing the production costs, revenues generated, and key financial performance indicators such as net profit margin, cost-benefit-ratio and return on investment (ROI). Two cages each of size 125m³ were installed in the reservoirs, stocked with 4000 all-male tilapia fingerlings each, fed with commercial diets and monitored monthly over a seven-month culture period. The sites survey as well as major water quality parameters analyzed were within optimal ranges, endorsing the suitability of the selected reservoirs. The fish growth parameters revealed an average growth of range 240-373g from an initial stock size of 2g. A simple profitability analysis from the two communities (Table 1) show a higher revenue generation at Nansoni community which reflected in a high profit margin and ROI. The benefit-cost-ratio suggest a breakeven at Tombu community as Nansoni community showed that it is economically viable. Although the cost of fingerlings was same among the communities, the feed cost varied as a result of some challenges such as fish escapes and mortalities in the Tombu community.

Although the culture in these reservoirs looks promising, however, other challenges such as high feed prices, limited technical knowledge, and climate variability pose risks to sustainability. The study concludes that with appropriate support in terms of credit access, training, and policy interventions, cage fish culture can be a sustainable and profitable enterprise for rural communities in Northern Ghana.

Table 1: Profitability indices of the fish culture

Parameter	Nansoni	Tombu
Revenue (GHS)	45200.0	37474.4
Fingerling cost (GHS)	4000	4000
Feed cost (GHS)	35112	30723
Labour cost (GHS)	1800	1800
Net Profit margin (%)	9.5	2.5
Benefit-cost-ratio	1.1	1.0
ROI (%)	10.5	2.6

NB: Profitability calculated based on variable costs

AGRICULTURAL RESEARCH COUNCIL: UNLOCKING SOUTH AFRICAN WOMEN'S POTENTIAL IN AQUACTIC RESEARCH AND DEVELOPMENT THROUGH CONTINUOUS IMPROVEMENT AND INNOVATION APPROACH

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The Agricultural Research Council (ARC) is dedicated to empowering women across a spectrum of roles, such as farmers, entrepreneurs, students and researchers. The ARC's aquaculture unit is managed by a woman and 70% of her staff members are women. She is an honorary Researcher at the University of the Witwatersrand where she mentors and supervises 70% female MSc and PhD students. The initiative gives women from underserved groups, including those with disabilities and those living in rural areas particular attention. ARC use a focused six-step Continuous and Innovation (CI&I) approach to maximize the effect of research and development in aquaculture, aquaponics and fisheries.

The CI & I is a process which enables individuals in teams to focus their thinking and actions on a regular and frequent basis in order to improve their performance by enhancing their practices, processes, systems, products and/or services.

The approach uses a framework that focuses on profit and productivity to evaluate farming methods and businesses in order to establish a common mental model of goals and an outcome focus. From the framework (figure 2) farmers can effectively learn that "efficient production is a factor of management, health, nutrition, genetics and marketing". As evidenced by ARC's high-value fish and vegetable partnership model focused innovations may be a potent tool for promoting resilience and equal opportunity for women in the agri-food sector.

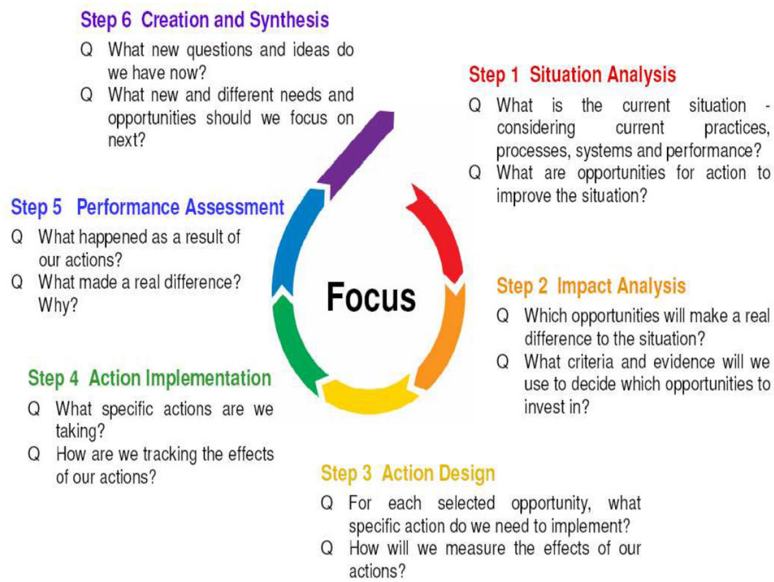

Figure 1: The six steps of the CI&I process and the questions used to focus thinking and action (Timms & Clark, 2007:76; Clark et al., 2005b:10)

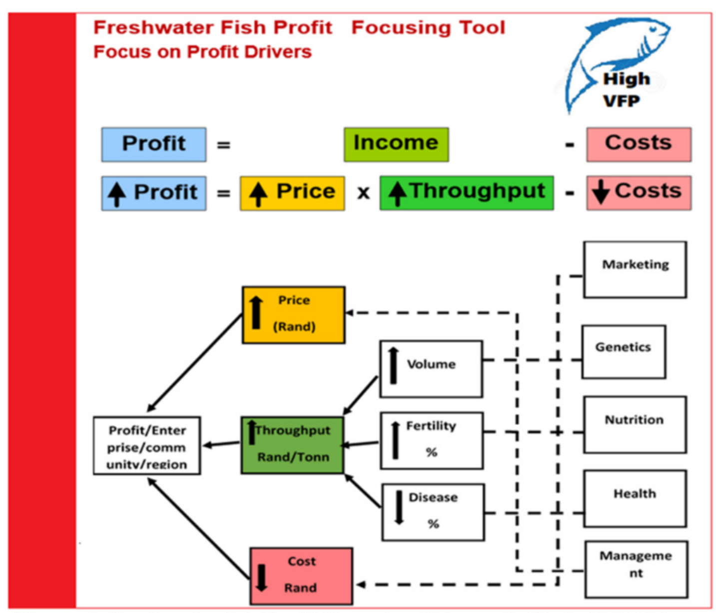

Figure 2: Freshwater fish Profit Focusing (Timms & Clark, 2007:24; Clark et al., 2005b:5).

COMPARING GROWTH PERFORMANCE AND ECONOMIC VIABILITY OF NILE TILAPIA (ORECHROMIS NILOTICUS) FED ON FOUR DIFFERENT PROTEIN INGREDIENTS (FISH MEAL (FM), TEREBRALIA PALUSTRIS (TP), BLACK SOLDIER FLY LARVAE MEAL (BSFL) AND BLOOD MEAL (BL) UNDER CONTROLLED AQUARIUM TANKS

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The study was conducted at the Kenya Marine and Fishery Research Institute (KEMFRI's) wet laboratory of the Mari culture department with an objective of investigating growth performance of Nile Tilapia (Oreochromis niloticus) fed on four different protein ingredients: fish meal (FM), Black Soldier Fly Larvae (BSFL), Terebralia palustris (TBP) and Blood meal (BM) protein sources. Fish were reared in 12 glass aquarium tanks of sizes 30 × 24× 24, feeding done twiceevery day for one month of 30 days. 240 fingerlings of sizes 0.5- 0.9 grams were randoml yselected from KMFRI raceways, conditioned for 2 days and distributed in the 12 aquarium tanks each holding 20 pieces. Feeding was done at 5% body weight throughout the study period.

Specific growth rate (SGR) was high on Oreochromis niloticus fed on Blood meal (BL) with 3.63 but not significantly different ($P > 0.05$) to the other treatments. The Fish Meal (FM) treatment was seen to have a higher FCR of 4.0 compared to the other treatments like BSFL which was seen to have 3.2, TP had 2.91 and BL was seen to be lower with 1.1. The Feed Conversion Ratio (FCR) values of FM and Black Soldier Fly Larvae (BSFL) were seen not to be significantly different ($P > 0.05$) but significantly different (P □ 0.05) to TP and BL. The b-values of all the treatments ranged from 0.01-0.33 showing not to be significantly different ($P > 0.05$) and condition factor of 1.59, 1.59, 1.54 and 1.49 for BL, BSFL, TP and FM respectively.

Water quality parameters were not significantly different in all the treatments ($P > 0.05$). Net returns above VC and TC were all positive on BL, TP and BSFL treatments but negative on the FM treatments. Under this condition, Fish meal protein was seen not to be cost-effective for the production of Oreochromis niloticus compared to the other protein ingredient hence a recommendation that other local ingredients should be used in running a profitable fish enterprise budget.

PUBLIC-PRIVATE PARTNERSHIPS IN THE AQUACULTURE INDUSTRY IN NIGERIA: SUCCESSES AND CHALLENGES

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Public-Private Partnerships (PPPs) offer a strategic pathway to address critical infrastructure deficits and prohibitively high interest rates stifling Nigeria's aquaculture sector. Despite immense potential for food security and economic growth, the industry faces severe constraints: inadequate hatcheries, feed mills, processing facilities, and cold chains, compounded by limited access to affordable financing. High commercial loan rates (often 25–40%) deter private investment, especially among smallholder farmers and SMEs, hindering productivity and value chain development.

This study examines how PPPs can mitigate these dual challenges by leveraging public resources (land, policy support, seed capital) and private expertise (technology, management, market access). It analyzes mechanisms such as:

- Infrastructure co-investment in hatcheries, processing plants, and logistics
- Blended finance models (e.g., concessional loans, credit guarantees) to reduce borrowing costs
- Risk-sharing frameworks to attract private capital

Key findings reveal that structured PPPs can:

- Modernize infrastructure to curb post-harvest losses (currently ~40%)
- Lower financing barriers via public-backed low-interest loans

However, success hinges on resolving regulatory fragmentation, securing land/water rights, and strengthening institutional capacity. Recommendations include creating dedicated aquaculture PPP units, expanding central bank intervention funds, and aligning policies with national agendas like the Fisheries and Aquaculture Policy (FAAP).

With targeted PPP frameworks, Nigeria can transform aquaculture into an engine of inclusive growth, food sovereignty, and resilience against climate and economic shocks.

EMPLOYING MULTI-GENOMIC TOOLS TO ELUCIDATE THE GENETIC STRUCTURE OF CAPTIVE AND WILD TILAPIINE POPULATIONS IN UGANDA TO CONTRIBUTE TO AQUACULTURE PERFORMANCE AND BIODIVERSITY SUSTAINABILITY

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The freshwater wild tilapiines are vital for augmenting aquaculture and economic development in Uganda. On the other hand, aquaculture development plays a pivotal role in the sustainability of wild fish stocks through minimizing overfishing threats. Therefore, both sectors play symbiotic roles in supporting each other. However, several challenges constrain aquaculture and wild/capture fisheries, including poor performance of the former. Most notably, the rampant, uncontrolled translocation of genetic materials, particularly tilapiines, between aquaculture systems and natural water bodies, could lead to a decline in biodiversity and ultimately threaten fish production and productivity. Currently, there is a paucity of information on the distribution and introduction of non-native strains and their potential effects on biodiversity in the Lake Victoria Basin. Additionally, albeit several factors that affect the aquaculture development, including water quality, fish feeds, and seed quality, are known, the genetic effects that could derail the performance of fish in captivity are less investigated. To address these gaps, we employed multi-genetic tools such as SSR, mtDNA, and SNPs to understand the genetic structure, diversity, and introgression levels of the key tilapiine species: *O. niloticus, O. esculentus, O. variablis*, and *O. leucostictus*. Our results revealed evidence of introgressive hybridization between the tilapiines. The results also indicated genetic admixture and structure based on the geographical location, with some populations revealing panmixia. We observed that pond-based Nile tilapia farms are admixed, contrary to cage fish culture. The genetic threats to the wild tilapia are mainly influenced by fish translocations. The genetic admixture in the pond-based Nile tilapia culture may contribute to the continued poor performance of the fish farms. These results are key to making informed decisions regarding the sustainable management of the wild fish stocks and aquaculture systems to enhance production and productivity in Uganda and in the EAC.

ADVANCING IMPROVED PROTECTION OF BIODIVERSITY IN THE LAKE VICTORIA BASIN THROUGH RESEARCH AND CAPACITY DEVELOPMENT

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The Lake Victoria Basin (LVB) is renowned for its rich biodiversity, particularly its diverse tilapiine species, which play a vital economic role in aquaculture across the East African Region. However, the sustainable management of these aquatic genetic resources faces numerous challenges, including uncontrolled movement of genetic materials between species and environments that may pose severe threats to biodiversity. WorldFish implemented Component 3.3 of the TRUEFISH project. The key aim of Component 3.3 was to improve protection of biodiversity by addressing the key risks to the long-term development and sustainability of the aquaculture sector, by minimizing the risk of accidental or intentional introduction of genetic material, which can threaten native species in the wild. In the project, WorldFish supported the development of aquaculture in EAC Member States by strengthening the assessment of risks of loss of biodiversity of natural populations and establishing policy briefs, institutional, and regulatory frameworks for the management of biodiversity risks. Key achievements include 1) the establishment and support of the LVFO working group on fish genetics and biodiversity, 2) LVB tilapiine genetic screening research, which indicated biodiversity risks such as genetic admixture, introgressive hybridization, and inbreeding, 3) science-based recommendations/scientific policy brief, 3) aquaculture genetic management plans and guidelines in EAC, and 4) Capacity building in aquatic genetic resources, management, and conservation.

These achievements are paramount and contribute to improved protection of biodiversity in the EAC's Lake Victoria Basin.

EFFECTS OF DIETARY ONION (*Allium cepa*) ON BLOOD PARAMETERS OF CATFISH AND AQUA-FARM WATER QUALITY

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Feed is an important factor in aquaculture with the individual ingredients being significant to the physiology of fish and to the condition of culture water. This study therefore investigated the effects of including onion at 0%, 1.02%, 2.05% and 3.07% in fish feed on the haematology of *Clarias gariepinus* and on water quality. The haematological parameters evaluated included red blood cell count (RBC), white blood cell count (WBC), packed cell volume (PCV), haemoglobin content, mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), and mean corpuscular haemoglobin concentration (MCHC). Furthermore, cholesterol and protein were determined using spectrophotometric-enzymatic and Bradford methods respectively. Albumin and glucose were determined using kits that detect albumin and glucose-oxidase reaction respectively. Globulin was calculated by subtracting the measured albumin value from the total protein. Water quality parameters evaluated were temperature, dissolved oxygen and pH.

There was significant increase (P<0.05) in RBC, PCV and Hb but decrease in WBC in the fish fed diet containing onion (Table 1.0). The decrease in WBC became significant (P<0.05 when onion was included at 2.05%. However the value of the WBC spiked when the onion concentration was 3.07%. There was no significant difference in the value of MCV at the studied concentrations. The increase in MCH due to onion in feed became significant (P<0.05) at 2.05%. Value of MCHC followed the same trend as MCH (Table 2.0). There was decrease in cholesterol and glucose due to onion in feed (Figure 1.0). There was increase in total protein and albumin but decrease in globulin due to onion in the diets (Figure 2. 0). Lowest globulin was observed when onion was included at 2.05%. There was no significant difference (P>0.05) in the water quality parameters studied among the treatments (Table 3.0). Results from the study suggest 2.05% as a preferred inclusion level of onion in feed for African catfish.

Table 1.0: Values of some haematology parameters of *Clarias gariepinus* fed diets containing different percentage levels of onion

Onion in diet	RBC Cells/µL	PCV %	Hb g/L	WBC Cells/µL
0%	3.67 ± 0.07^c	25.8 ± 0.91^c	9.2 ± 0.2^b	9.44 ± 0.66^a
1.02%	3.97 ± 0.12^b	27.8 ± 0.80^b	9.96 ± 0.47^b	9.38 ± 0.30^a
2.05%	4.15 ± 0.06^a	28.9 ± 1.00^b	11.4 ± 0.45^a	8.69 ± 0.22^b
3.07%	4.30 ± 0.11^a	30.9 ± 0.51^a	11.6 ± 0.30^a	9.17 ± 0.98^b
Test	*	*	*	*

Mean with the same superscript letter in the same row are not significantly different at P<0.05

Table 2.0: Values of MCV, MCH and MCHC in *Clarias gariepinus* fed diets containing different percentage levels of onion

Onion in diet	MCV fL	MCH Pg	MCHC g/L
0%	70.16 ± 1.94	25.01 ± 0.55^b	35.66 ± 0.51^c
1.02%	69.96 ± 0.14	25.08 ± 0.83^b	35.84 ± 1.15^c
2.05%	69.72 ± 1.33	27.43 ± 0.63^a	39.34 ± 0.28^a
3.07%	71.88 ± 0.68	27.10 ± 0.52^a	37.71 ± 0.60^b
Test	Ns	*	*

Mean with the same superscript letter in the same row are not significantly different at P<0.05

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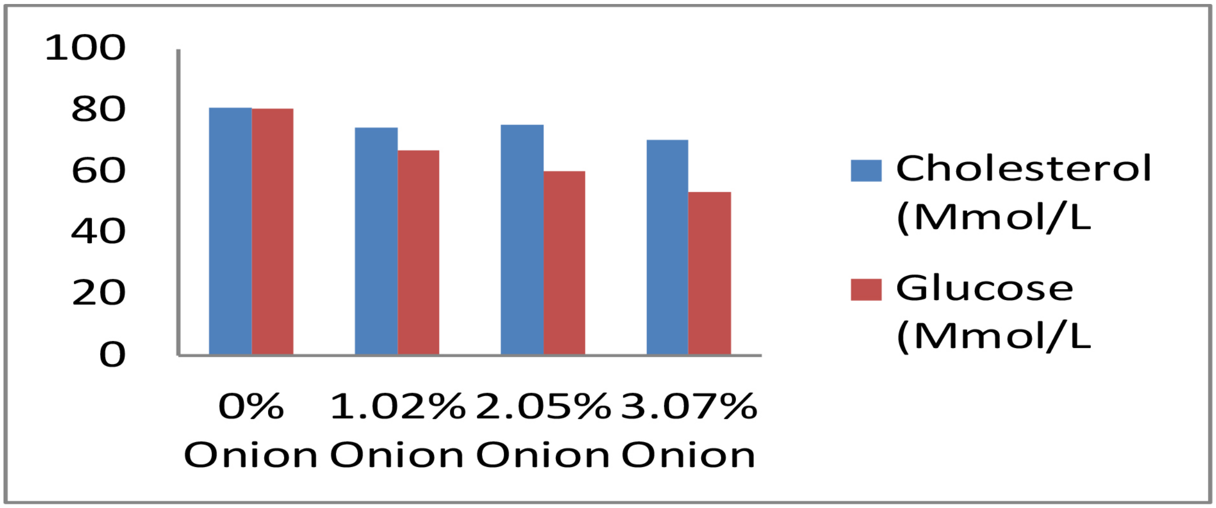

Figure 1.0: Effect of onion in feed on level of cholesterol and glucose in blood of catfish

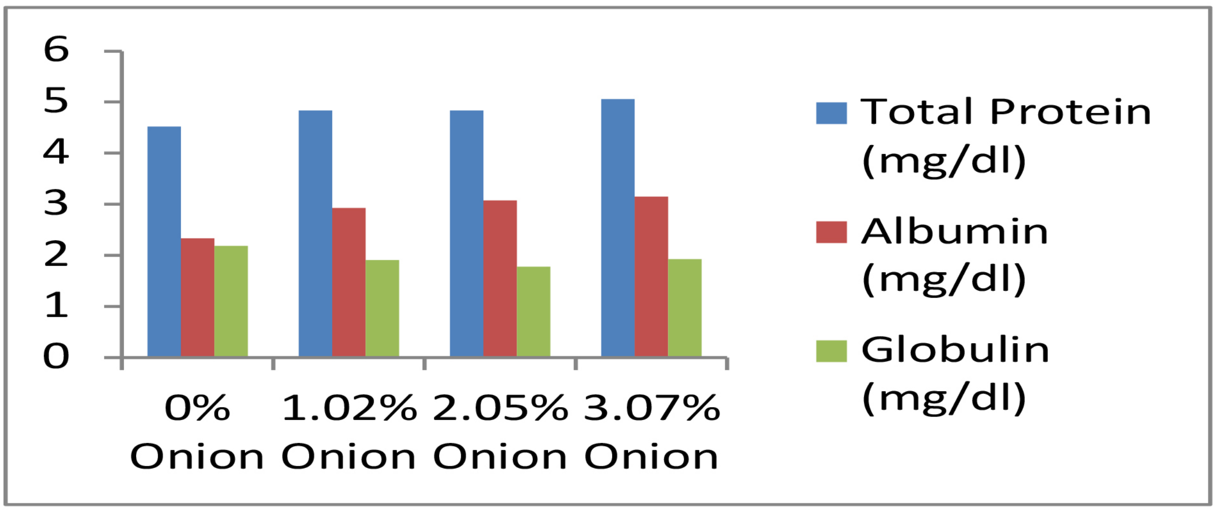

Figure 2.0: Effect of onion in feed on level of protein, albumin and globulin in blood of catfish

Table 3.0: Impacts of treatments on water quality

	pH	DO (mg/L)	Temperature (°C)
0%	5.04	18.75	315
1.02%	5.05	18.50	31.70
2.05%	5.24%	18.20	31.70
3.07%	5.43%	18.00	31.50
Test	ns	ns	ns

INCORPORATING INSECT MEAL AND SPIRULINA IN DIETS FOR NILE TILAPIA: OPPORTUNITIES AND CHALLENGES FOR AFRICAN AQUACULTURE

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African aquaculture is a rapidly growing industry that provides a sustainable source of protein while supporting job creation, economic stability, and equal opportunities across communities. To sustain this growth, innovative protein sources are crucial for advancing the aquaculture and aquafeed sectors. The INNOECOFOOD project aims to strengthen fish farms by evaluating protein sources produced locally within ECOHUBS, including spirulina and black soldier fly (*Hermetia illucens*) larvae meal (BSFLM). This initiative promotes efficient aquaculture practices while supporting the production of certified, marketable food and feed products. Nile tilapia (*Oreochromis niloticus*) is a key species in African aquaculture, valued for its fast growth and high yield. As demand for sustainable and cost-effective fish production rises, diversifying feed ingredients is crucial. Therefore, the objective of this study was to evaluate the incorporation of Spirulina and BSFLM in diets for Nile tilapia juveniles. Five practical diets were formulated (35 % crude protein, and 8 % crude lipids). A control diet contained 5 % fishmeal (FM), while for the other experimental diets, FM-protein was partially (25 %) replaced by either BSFLM, or spirulina, or totally (100 %) by a combination of 75 % BSF and 25 % spirulina, or 100 % BSF. Diets were tested in triplicate with groups of 20 Nile tilapia juveniles (initial body weight 8.2 ± 0.03 g) and fish were hand-fed to apparent visual satiation for 71 days. At the end of the trial, growth performance and feed utilization showed no differences among treatments. Final body weight averaged 88.7 g, daily growth index 3.43 % day^{-1}, and feed conversion ratio 1.14. Diet's nutrient digestibility, retention, and gain remained unaffected by the experimental diets. The histomorphological evaluation revealed no significant effects on the intestinal integrity of fish fed these diets. Overall, the present results demonstrate the feasibility of replacing FM with spirulina and BSFLM as innovative feed sources in diets for Nile tilapia, without compromising growth, feed efficiency, or digestive health. The impact of the diets on the nutritional quality of tilapia fillets is still under study. These findings highlight the potential for locally-produced alternative proteins to enhance the sustainability and self-sufficiency of African aquaculture systems while reducing dependency on imported fishmeal.

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Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union, nor the granting authority can be held responsible for them.

ENHANCING *Paracentrotus lividus* ROE COLOR AND SENSORY QUALITY WITH A *Dunaliella salina*-SUPPLEMENTED FINISHING DIET

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Scaling up echinoculture to a commercial level depends on the development of sustainable, safe, and long shelf-life diets. Previous studies have developed cold-extruded dried diets for *Paracentrotus lividus* that allowed achieving high gonad yields and good quality roes [1]. However, finding a cost-effective solution to maintain the desired quality standards while keeping up with the consumer expectancies in such a delicate product remains challenging.

This study assessed the potential of a cold-extruded diet enriched with *Dunaliella salina* as a finishing feed for *P. lividus*, by evaluating its effect on carotenoid deposition and organoleptic properties at two different times in order to assess the minimum time required to achieve high quality roes. Furthermore, a sensorial analysis was performed to evaluate the consumers perception on the obtained roes.

A pilot-scale trial was conducted over 8 weeks in quadruplicate, where separate groups of sea urchins were kept in RAS at 15ºC, feeding every second day on two diets: one diet enriched with *D. salina* (1.5%) as a finishing feed for *P. lividus* (DUN) and one control diet (CTRL) with an identical formulation and similar proximate composition but without *D. salina*. After 4 and 8 weeks, gonad carotenoid content, color, and texture were analyzed. Sensory quality was evaluated using the Rate-All-That-Apply analytical method by 30 untrained panelists.

Both diets have equally enhanced the gonadosomatic index (GSI) and gonads texture throughout the experiment. The DUN diet significantly improved the color of female gonads by increasing carotenoid deposition within 8 weeks. Notably, color enhancement was already evident at 4 weeks, reaching a level comparable to gourmet standards, with further improvement by week 8. While the effect on male gonads was less pronounced, DUN still contributed to their color enhancement after 8 weeks. DUN also reduced the unappealing milky white appearance pointed out by the panelists in male gonads.

This study results show that 4 weeks was enough to achieve a marketable GSI, acceptable texture, and enhanced gonad color in females, but by this point, male gonads had yet to reach a commercially viable GSI. Extending the feeding period to 8 weeks proved optimal for maximizing the DUN diet's potential, leading to improved size, color, and texture in *P. lividus*.

Acknowledgments: This work was partially funded by Innovation Pact (Project No. C644915664-00000026/Notice No. 02/C05-i01/2022, "Blue Bioeconomy Pact", funded by the European Union through the Recovery and Resilience Plan - PRR).

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LOW-TROPHIC MARINE SPECIES *Gammarus locusta* AND *Hediste diversicolor* AS DIETARY SUPPLEMENTS FOR GILTHEAD SEABREAM

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Due to their nutritional profile, polychaetes and gammarid amphipods are increasingly being recognized as promising ingredients/supplements for the formulation of aquafeeds for marine species [1,2]. To advance the state of the art, the present study investigates the potential use of the polychaete *Hediste diversicolor* and the gammarid amphipod *Gammarus locusta* as dietary supplements for gilthead seabream *Sparus aurata*, assessing their impact on growth performance and feeding efficiency.

A growth trial was performed using juvenile gilthead seabream (averaging 16 g) at 23 **ºC**. Different groups of fish were fed one of the four experimental diets formulated to be isoproteic (52%), isolipidic (18%) and isoenergetic (25kJ g^{-1}): a high-quality diet including 13% of Super Prime Fishmeal and 7% of Fishmeal60 used as a positive control (PC); a diet containing approx. 50% of vegetable ingredients and only 7% of Fishmeal60 used as a negative control (NC); and two other diets (GAM and HED) that had the same formulation as the NC but included 2.5% *Gammarus* or *Hediste* meals at the expense of corn gluten protein. All diets were tested using 4 replicates of 35 fish stocked at a density of 2.8 Kg/m^3. Fish were hand-fed to apparent satiety three times a day. After 61 days, all fish were individually measured and weighed. Five fish per tank were sampled and analyzed for whole-body composition for further evaluation of nutrients retention and gains.

All diets were well accepted, but fish fed GAM and HED showed higher voluntary feed intake (~2.8 g/100g BW/day) than NC (~2.3), similar to PC (~2.7). However, while GAM-fed fish reached a final body weight (~68,9 g) comparable to PC (~71,9 g), both HED and NC fish displayed lower weights (~68.6 and 67.5 g) when compared to PC. The hepatosomatic index was significantly higher in PC than in other groups, suggesting possible metabolic changes.

This study highlights the potential of a locally sourced low-trophic species (the gammarid amphipod *Gammarus locusta*) as an effective alternative to Super Prime Fishmeal in aquafeeds for gilthead seabream. Supplementing a negative control diet with 2.5% of *Gammarus* meal enabled juvenile gilthead seabream to achieve a weight comparable to those fed the positive control, possibly associated with an increased acceptability of this diet.

Acknowledgments: This work was funded by Innovation Pact (Project No. C644915664-00000026/Notice No. 02/C05-i01/2022, "Blue Bioeconomy Pact", funded by the European Union through PRR.

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INSECTS AND ANIMAL BY-PRODUCTS AS SOURCES OF FUNCTIONAL PROTEIN HYDROLYSATES FOR AQUACULTURE

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Aquaculture now supplies over half of the fish consumed globally, positioning it as a critical solution to meet rising protein demand. However, its expansion is constrained by limited availability of high-quality feed ingredients, such as fishmeal. As this ingredient becomes increasingly strategic, the sector must explore alternatives that fulfill nutritional requirements while maintaining fish robustness under modern feed formulation scenarios.

The Pep4Fish project developed and evaluated protein hydrolysates (PHs) derived from *Hermetia illucens* larvae and animal by-products – including fish by-products from processing and canning industries, and swine by-products from slaughterhouses - as functional aquafeed ingredients. These PHs, rich in bioactive peptides and produced from upcycled raw materials, align with circular economy principles. Several feeding trials were conducted with European seabass (*Dicentrarchus labrax*) and gilthead seabream (*Sparus aurata*) using practical feed formulations currently used by the industry.

Among the tested PHs, swine-derived hydrolysate showed the highest potential, maintaining feed intake, macronutrient digestibility, and whole-body composition, even when replacing high-quality fishmeal and a commercial fish hydrolysate. Effects on growth and somatic indices were formulation-dependent. Altered lipid metabolism emerged as a key physiological response to both dietary composition and environmental stressors.

These findings support the inclusion of hydrolyzed *Hermetia illucens* larvae and animal by-products as functional ingredients in aquafeeds, contributing to waste valorization, reduced reliance on marine resources, and enhanced sustainability of aquaculture systems.

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EXPORTING AQUACULTURE PRODUCTS TO THE EU – AN INTRODUCTION

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The European Union (EU) is currently the world's biggest importer of fish, seafood and aquaculture products. The EU produced only 1.1 million tons of farmed fish in 2022 (less than 1% of global production), but consumed approximately 3 million tons of aquaculture products and 7 million tons of fishery products.

EU legislation often applies uniformly to both wild-caught and farmed products: all fish products for human consumption in the EU must meet the same EU general food safety and hygiene rules. However, aquaculture is distinct from capture fisheries because farmed fish requires controlled conditions including specific infrastructures, management of water and waste, and external inputs such as feed. This means that certain requirements for aquaculture products are different from those for wild catch.

Meeting EU Regulations and Standards remains a major determinant for market access and competitiveness. Both operators and competent authorities in countries exporting aquaculture products to the EU must be aware and work together to meet EU standards. So competent authorities in exporting countries must have a robust and reliable system in place to allow safe aquaculture production, covering aspects such as food safety, veterinary residues and diseases, while overseeing the inspection and compliance of products exported by operators from their country.

COLEAD (Committee Linking Entrepreneurship-Agriculture-Development), a not-for-profit private sector association, within the scope of its EU-funded AGRINFO information service, helps exporters navigate the complex and continually evolving EU regulatory framework and agri-food market requirements, including those for aquaculture.

To help ensure that exported produce – including that from small-scale producers and operators – remains compliant and retains access to the EU market, our introductory guide to exporting aquaculture products offers producers, processors, traders and competent authorities a concise overview of EU requirements that must be met to export aquaculture products to the EU.

HOW CAN AQUACULTURE IMPROVEMENT PROJECTS WORK FOR SMALLHOLDER FARMERS IN AFRICA?

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Aquaculture Improvement Projects (AIPs) were developed as a mechanism for supply chains to address challenges in aquaculture production sectors against global standards. Various AIP approaches have been developed over the years. ASC created an Improver Programme to provide supply chain companies with a framework that could help farmers move towards ASC certification in a consistent, transparent and meaningful way. Pilot examples in shrimp have been delivered in Indonesia, Thailand and Bangladesh. Building on lessons learnt from those projects and in recognition of the global reach and variety of aquaculture production systems, ASC has been exploring how the approach can be expanded to meaningfully support smallholder farmers in *any* aquaculture sector to benefit from structured improvement. The idea moves further away from certification as an end goal and aims to make farmers, farms and whole aquaculture sectors more productive.

Typically, improvement projects have engaged seafood buyers and other actors at the downstream end of the supply chain. However, these projects remain focused on improvements to meet certification for international markets, leveraging markets based incentives to drive such improvements. Research by ASC and ThinkAqua, building on decades of experience delivering both classical development projects and supply chain-led AIPs has identified an opportunity to support small and medium enterprises through other models that are not reliant on international markets only.

A critical entry point to reach aquaculture farmers is through engagement with local feed companies. Typically, the most expensive component of any project working with smallholders or fragmented supply chain is the last mile to reach farmers with technical knowledge and inputs, and to provide them with a cost-effective route to market. This role is often filled either by technical sales teams from feed companies or by middlemen (agents) who have a commercial relationship with feed companies or off-takers. These agents often provide credit too, either formally or informally.

Engaging feed companies (or their agents) makes sense in many aquaculture sectors because they typically have a longer-term vision of sector sustainability. However, not all projects will look the same because needs will vary, even if the overarching aim will be to strengthen aquaculture production. This can be achieved through a blend of four sub-models that have been proven in various relevant contexts: creating industry associations / jurisdictional entities; developing local Codes of Good Practice; creating or supporting service delivery model business scaling; and increasing access to finance.

Feed companies will not provide an entry point in sectors that do not require feed – for example, seaweed production or extensive/household fish production, but some of the sub-models explored by ASC can be used with other agents in such industries.

DE HEUS AQUAFEED IN UGANDA: GLOBAL EXPERTISE USED FOR LOCAL PRODUCTION

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De Heus Animal Nutrition has a longstanding commitment to advancing aquaculture through global research and development. Founded in 1911 as a Dutch family business focused on milling and trading feed ingredients, De Heus has grown into a global animal nutrition company with operations in more than 75 countries. The company began its aquafeed activities in the early 2000s in Asia, gradually expanding its expertise and production capacity. From the start, investing in quality has been crucial. A major milestone was the opening of the Aquaculture R&D Center in Vinh Long, Vietnam, in 2017. This fully equipped facility enables De Heus to test innovative feed formulas and novel raw materials, focusing on species such as Tilapia and African catfish.

De Heus sees great potential for aquaculture far beyond Asia, especially in Africa. This vision has led to exports across many African countries, allowing the company to combine global expertise with valuable local knowledge. Based on these experiences, De Heus established dedicated aquafeed facilities in Ghana, Egypt, and Ethiopia, further strengthening its local presence.

In Uganda, De Heus has been active through its Koudijs brand since 2018, providing trusted animal nutrition solutions to both livestock and aqua farmers. De Heus is now entering a new chapter by establishin gits own aquafeed factory, transitioning the aquafeed brand from Koudijs to De Heus.

After building relationships with customers, learning from the local expertise and seeing the market potential, De Heus is now building a state-of-the-art aquafeed facility to support our customers with locally produced feed, ensuring a stable supply without depending on feed imports. This factory is expected to produce up to 100,000 metric tons of fish feed per year at full capacity, meeting the growing demand in the East African market. Our local team will use its expertise to support customers on the ground while being backed by our global formulation department based in the Netherlands—ensuring international standards are adapted to local needs. In addition, we have established a laboratory for extensive quality testing, so our customers can expect the same premium feed quality as they have come to trust from our operations in Vietnam.

This investment reflects De Heus's commitment to empowering East African fish farmers with high-quality, locally produced aquafeed and contributing to the sustainable development of the region's aquaculture sector.

A GHANA LAKE WATCH PROGRAM THAT WILL TRACK DISSOLVED OXYGEN AND TEMPERATURE PROFILES AT SELECTED CAGE SITES

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A small project was funded by the United States' Nebraska Soybean Board to develop a new methodology for farms on Lake Volta, Ghana to track changes in the thermocline (Fig 1) and associated dissolved oxygen levels and communicate potential risks to nearby farms by sharing the data through the Chamber of Aquaculture in Ghana. The measuring devices were installed to log hourly measurements of dissolved oxygen and temperature at various depths to detect where the thermocline is and to track the thermocline depth to relate any changes to weather events, rapid cooling of the surface or sudden algae die-offs. Deployment of the data loggers will be altered as data are analyzed to identify the depth where an abrupt change in water temperature occurs.

In temperate zones, lake turnover (when the bottom layers of low-oxygen water rise to mix with the upper layers of more oxygen-rich waters), is well known to be a seasonal event both in spring when ice is melting and in fall when ice is forming. In the tropics, the thermocline tends to be much shallower, and turnover can occur much more frequently and unpredictably, especially in eutrophic waters.

There have been several large-scale fish kills at cage culture operations in the tropics that have been the result of mixing of very low- dissolved oxygen water with surface waters where the cages are located; some of which could have been predicted if changes in the thermocline depth were being monitored. First, the approximate thermocline will be sought by comparing water temperature at surface and bottom. If there is a difference, then the point of the thermocline will be estimated by working upwards to seek the point of a temperature change.

In this presentation we will describe the inexpensive monitoring system used at 2 cage culture sites: one being in the "open lake", where large cages are used, and water quality is very good for at least the first 8 meters. The second site is at the opening of a bay on the lake where intensive cage culture occurred several years ago but has since been reduced. A combination of dissolved oxygen/temperature loggers and less expensive temperature loggers are being used. Secchi disk readings, weather observations and fish feeding behavior are also being tracked.

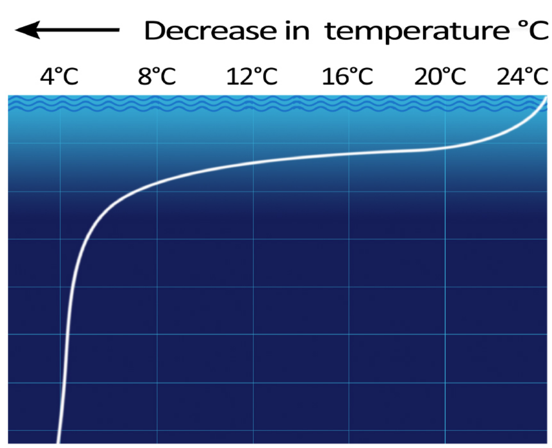

Fig 1:An illustration of thermocline in a deep waterbody. Adapted from Praveenron - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=31055923

WISHH FARMER SESSIONS – KNOWING THE NUMBERS

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The World Initiative for Soy in Human Health (WISHH) will host two days of farmer sessions at the Aqua Safari 2025 conference in Kampala, Uganda. These sessions are designed to address some critical needs of aquaculture farmers in sub-Saharan Africa, focusing on applied knowledge to enhance business success. The sessions emphasize financial literacy, specifically linking best management practices to financial returns. Participants will learn how to accurately cost their operations, understand gross profit margins, and improve profitability without necessarily increasing investment. Key topics include cost of sales analysis, feed management, water quality, disease impact on FCR, investor preparedness, and risk mitigation in aquaculture. The sessions also aim to bridge the gap between farmers and investors by helping farmers understand investor perspectives on risk. The sessions also afford networking opportunity for financial institutions to meet farmers to further aquaculture financing.

REPRODUCTION CHARACTERISTICS OF EMPEROR FISHES: *Lethrinus mahsena* (Forsskal, 1775) AND *Lethrinus harak* (Forsskal, 1775) AND IMPLICATIONS FOR AQUACULTURE

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Globally, human population is increasing and therefore there is need for diversification of aquatic food sources to meet the demand. Capture fisheries are declining due to climate change impacts, over exploitation and use of poor fishing methods. Aquaculture stands out as the focus to address he gap in aquatic food systems production though there are limitations in freshwater aquaculture due to the limited number of species farmed and competition of water with agriculture thus the focus on marine aquaculture. In sub-Saharan Africa, only a small number of marine fish species have been brought into aquaculture hence the need to understanding the biology and preference of other potential species. *Lethrinus mahsena* (Forsskal, 1775) and *L. harak* (Forsskal, 1775) are widely distributed in the coastal waters of the Indo-Pacific region. They are important commercial and recreational fishery and are key to the livelihoods of artisanal fishing communities. This study was conducted at Bofa, Old ferry and Takaungu landings sites in Kilifi County over a period of three months (December- February). Biometric data was collected at the field while gonad analysis was undertaken in the laboratory at Pwani University. The length weight relationship in *L. mahsena* and *L. harak* showed isometric growth in both sexes, with females significantly larger than males in both species. Most individuals were at maturity stage II with a few observed at stages III and IV. In *L. mahsena*, female body size showed no significant correlation with fecundity, whereas in males, body size was positively correlated with gonad size. In contrast, *L. harak* exhibited a positive correlation between fish size and fecundity in females as well as fish size and gonadal weight in males. Regarding fish health and reproductive potential, the condition factor (K) in *L. mahsena* was positively associated with oocyte count in females but not in males while *L. harak*, female condition factor was positively correlated with body size but not in males. The findings indicate that it's possible to collect mature brood-stock for hatchery breeding purposes although between December and February the maturity rate is lower. Further, the results obtained provides useful information to guide improved brood stock selection and breeding strategies for sustainable cultivation of the two species.

ON-FARM ASSESSMENT OF DIFFERENT FINGERLING SIZES OF NILE TILAPIA (*Oreochromis niloticus*) ON GROWTH PERFORMANCE, SURVIVAL AND YIELD

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Rapidly increasing hatchery-raised Nile tilapia (*Oreochromis niloticus*) in most developing countries lack informed recommended fingerling weight for stocking in semi-intensive grow-out ponds. The current study assessed the growth performance, survival and productivity of all-male Nile tilapia fingerlings of 0.2 g, 1 g, and 5 g in an on-farm experiment. The final mean weight of fingerlings stocked at size 5 g was significantly higher (113.80 ± 4.21 g) ($P< 0.05$) compared to the 0.2 g (36.99 ± 1.14 g) and 1g (91.93 ± 5.59 g) fingerling sizes. The mean daily weight gain was highest in 5g stocked fingerlings (0.91 ± 0.04 g day $^{-1}$) resulting in significant differences in the final mean weight. The coefficient of correlation between fish body length and weight was high and positive ranging (R = 0.95 - 0.98). Significantly low percent survival was recorded in 0.2g stocked fingerlings (64.43 ± 1.93%). The net fish yield (NFY) and profit index (PI) were significantly lower at the 0.2 g. The highest NFY and PI were recorded in the 5 g stocked fingerlings (8.59 ± 0.09 tons ha^{-1} year^{-1} and 6.6 ± 2.08), respectively. Thus, with appropriate Nile tilapia fingerling weight at stocking, fish farmers can maximize fish growth, yield and profits.

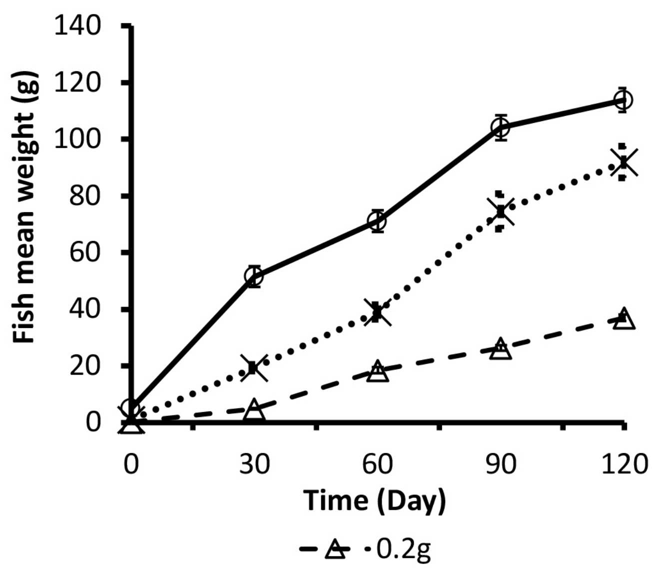

Figure 1: Mean growth of body weight ± s.e of Nile tilapia, *O. niloticus* stocked at different weights at 0.2 g, 1.0 g and 5.0 g reared in ponds

OPTIMIZING FISH PRODUCTION FROM TWO SMALL WATER BODIES IN NAKURU COUNTY AS A CATALYST FOR BLUE ECONOMY DEVELOPMENT

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Small water bodies (SWBs) including ponds, reservoirs, and small lakes are the most abundant freshwater ecosystems globally and hold significant potential for fisheries development, contributing to sustainable food production, livelihoods, and local economies. Despite their abundance, SWBs have historically received limited attention in fisheries management plans. However, with declining fish yields from large lakes and rivers, there is a growing interest in utilizing SWBs for aquaculture and fisheries enhancement.

A study conducted in Nakuru County, Kenya, assessed the fishery potential of two SWBs—Lake Kenyatta and Solai Dam by examining their water quality, biological productivity, and fish populations. Sampling in April 2022 and 2023 revealed that water quality parameters, such as dissolved oxygen (mean of 7.0 ±1.44 mg/L in 2022 and 8.1 ±0.18 mg/L in 2023) and pH values within the recommended range of 6–9, were conducive for fish growth. Conductivity levels and nutrient concentrations, including nitrates and phosphates, were within tolerable ranges, although total suspended solids were high across all stations sampled.

The biological assessment indicated a healthy presence of zooplankton, with Copepod and *Lovenula africana* recording the highest bio-volume (260,010 individuals per litre), and phytoplankton species such as *Ceratium hirundinella*, *Nitzschia palea*, and Chlorella vulgaris showing high abundance (>100 individuals per litre). These findings suggest good ecological health capable of supporting fish restocking and farming. Fish sampling revealed that the sizes of *Clarias gariepinus* (mean length of 46.45±5.7 cm) and *Oreochromis niloticus* (mean length of 24.6±6.3 cm) were within the recommended table size ranges for harvesting. The condition factors for both species were above 1.00, indicating excellent growth conditions.

Based on these findings, the study recommended restocking the dams with *C. gariepinus* and *O. niloticus*, synchronized with seasonal water level fluctuations. Additionally, training local communities on fishing methods, processing, and fish marketing was advised to enhance fisheries development. Exploration of other SWBs in Nakuru County for potential fishery development was also recommended. These insights underscore the importance of integrating SWBs into fisheries management strategies to bolster food security and support the blue economy.

MARICULTURE IN KENYA: A PATHWAY TO POVERTY ALLEVIATION THROUGH INCOME GROWTH

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Mariculture in Kenya today serves as a means by which the coastal population is able to secure its subsistence and its commercial welfare. As a pathway to the increasingly touted Blue Growth, Mariculture is more and more being acknowledged by the government as a vehicle through which transformational socio-economic development can be achieved. Common mariculture practices in coastal Kenya are fin-fish farming, shellfish farming, as well as Crab and Seaweed farming. Policy frameworks, both local and global, are in place to encourage the growth of mariculture as an integral sub-sector of the larger fisheries sector. While financial gains (and the associated benefits) from coastal mariculture activities have been realized, structural short-comings in both policy and practice have not allowed for its full potential to be achieved. Although the human and natural capital necessary for mariculture in Kenya to thrive abound, financial and built capital have not kept pace; this together with unreliable access to markets continue to stifle the sub-sector's growth. An overview of the current state of the sub-sector is presented, as are recommendations necessary for it to flourish and provide more locals with incomes for their survival.

NATURAL DIET AND FEEDING HABITS OF FRESH/BRACKISH WATER PRAWNS GENUS MACROBRACHIUM (FAMILY PALAEMONIDAE) IN KENYA

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The fresh/brackish water prawns of the genus Macrobrachium comprises 243described species spanning the tropical and subtropical regions globally which include *M. rude*,M. *dolichodactylus*, *M. equidens*,,*M. lepidactylus* and *M. niloticus* species in Kenya. The importance of amphidromous Macrobrachium species as human food source and its ecological role is well recognized. However, there is limited information on their natural diet and feeding habits in Kenya limiting the aquaculture potential of some of these prawns.

A total of 343 specimen samples consisting of M. rude(220; 64.4%), M. lepidactylus (77; 21.9%) and M. dolichodactylus (46; 13.7%) per different sexes and size groups ranging from 20 to 231mm were analyzed. A total of 80 different types of food items identified (Figure 1). In terms of stomach fullness index, 70.2% of M. rude recorded ¼ full index while 29.4% of M. dolichodactylus and 33.3% of M .lepidactylus recorded full stomach indexes. The results revealed significant differences in frequency occurrence of food items between different Macrobrachium species, sites, seasons, size lengths, sexes and stomach fullness index ($P<0.05$). The most dominant food items were sand particles (16%), unidentified plant materials (9.5%), unidentified animal materials (6.8%), algae, Ankistrodesmus sp (6%) and microplastics (4.3%) (Figure2).

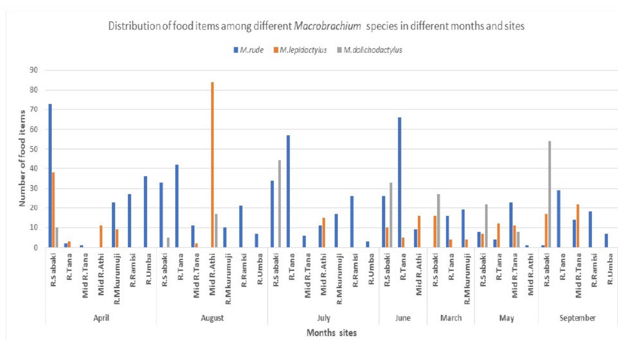

Figure 2

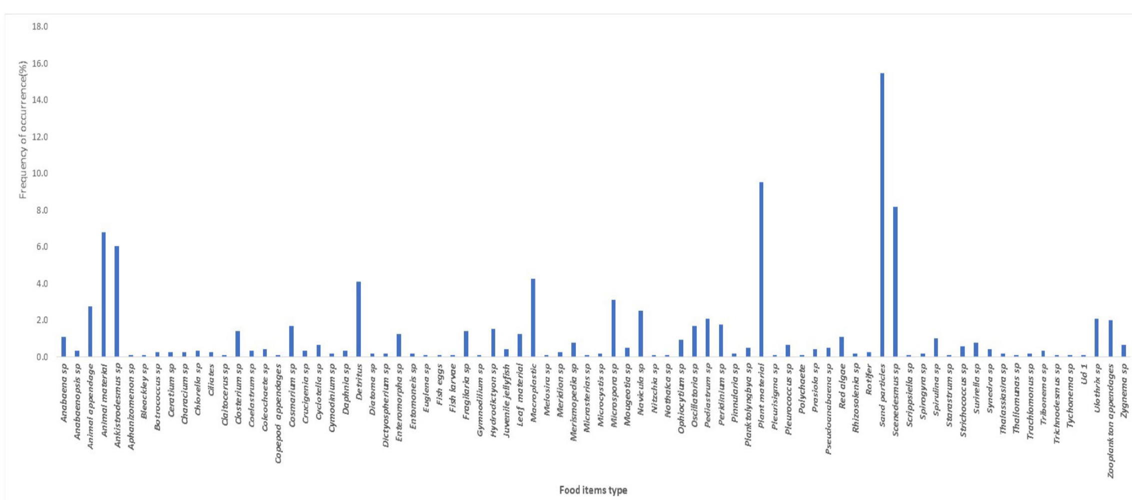

figure 1

OCCURRENCE AND ANTIBIOTIC SUSCEPTIBILITY OF FRANCISELLA AND VIBRIO SPECIES ISOLATED FROM TILAPIA FROM SELECTED FARMS IN THE LAKE VICTORIA BASIN IN UGANDA

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Aquaculture in Uganda is rapidly expanding, with *Oreochromis niloticus* being the predominant farmed species in the Lake Victoria basin. This growth, driven by the need to offset declining wild fish stocks, has intensified production and increased the risk of bacterial diseases such as those caused by Vibrio and Francisella species. These pathogens not only threaten fish health and farm productivity but also raise concerns about antimicrobial resistance, especially in the case of Vibrio, which has public health implications.

This study aims to determine the occurrence, antibiotic susceptibility, and resistance gene profiles of Francisella and Vibrio species isolated from farmed tilapia in the Lake Victoria basin. Ninety fish samples were collected across 9 cage farms and analyzed using microbiological, biochemical, and molecular techniques. No Francisella spp. were isolated from the samples.

Vibrio spp. were successfully isolated, with the following distribution: *V. vulnificus* (26), *V. alginolyticus* (4), *V. diazotrophicus* (4), *V. parahaemolyticus* (3), and *V. cincinnatiensis* (3). Antibiotic susceptibility testing revealed that *V. alginolyticus* and *V. parahaemolyticus* were only resistant to ampicillin, consistent with their Gram-negative profile. However, V. vulnificus exhibited notable resistance to tetracycline (10 isolates), trimethoprim-sulfamethoxazole (14), cefepime (7), imipenem (4), and gentamicin (1), indicating emerging multidrug resistance.

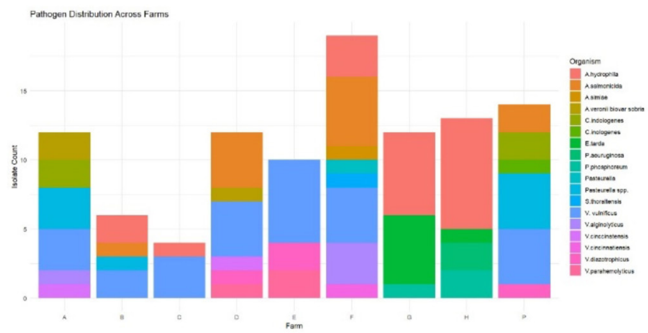
Tentative results

Antimicrobial susceptibility

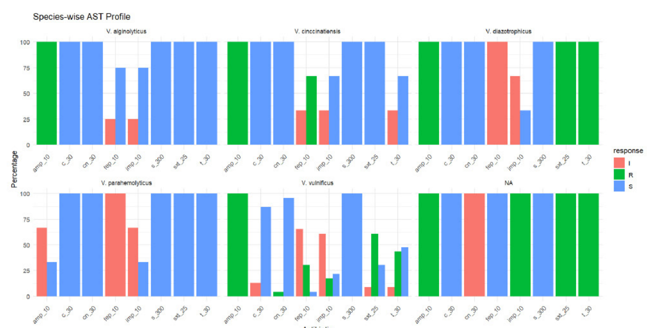
The study assessed the susceptibility of *Vibrio* isolates to eight antibiotics spanning seven major classes.

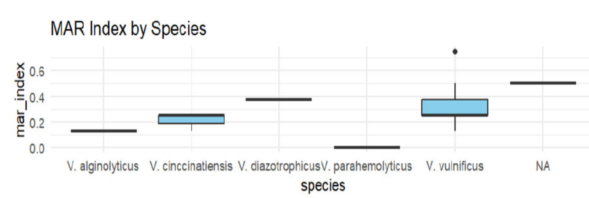
Conclusion

These preliminary findings highlight the importance of continued surveillance and responsible antibiotic use in aquaculture. The next phase of the study will focus on the molecular characterization of Vibrio species of interest to fish health, including identification of specific virulence factors and antimicrobial resistance genes. This study aims to support biosecurity planning, sustainable antibiotic usage and inform policy for sustainable aquaculture in Uganda.

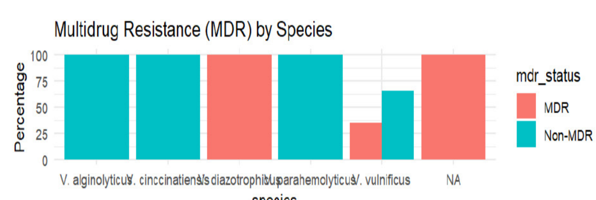


Pathogen Distribution Across Farms





Multiple Antibiotic Resistance index by species



Multidrug Resistance by species

RECENT ADVANCES OF BIOFLOC TECHNOLOGY SHRIMP CULTURE SYSTEM IN SOUTHERN BRAZIL

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Biofloc Technology Culture Systems (BFT) is characterized by zero water exchange and super-intensive culture of shrimp in enclosed raceway type. This type of system is considered environmentally friendly and avoids nutrient rich waste from polluting coastal waters. However, as a new strategy for shrimp production, there is much still to be learned about the benefits of producing shrimp BFT systems to enhance the commercial potential of the system. For that reason, several experiments have been carried out trying to find some of the keys for technical and economic feasibility of BFT shrimp superintensive culture systems.

Technological innovation permits increases in shrimp production capacity per unit area. The addition of new management tools such as air injectors (nozzles), nitrification and denitrification process, use of clarifiers and some new procedures may allow increases in the load capacity of these systems.

For example, the demand for dissolved oxygen (DO) by shrimp is one of the main concerns as culture systems intensify. In intensive or super-intensive culture of shrimp can be possible if the system's aeration devices can meet the organism's oxygen demand. The number of devices to be used will depend on the water's salinity and temperature, stocking density, shrimp size, and the amount of suspended solids in the BFT systems. For this reason, studies and evaluations of the support capacity of each new aeration technology is important to maximize its effect.

Therefore, several researchers have evaluated the influence of the limitation of different parameters and procedures. These are important challenges to overcome the production when working in BFT with high densities, and different devices and other procedures (Table 1), that can have significant impacts on shrimp development in super-intensive system.

In the present study we will present evaluations of some of these important generated technologies for BFT systems, and we will discuss the influence of high stocking densities on water quality and on the growth performance of *P. vannamei* in a BFT system.

Table 1: Recent developed technologies for Biofloc Technology super-intensive shrimp culture systems in Southern Brazil

BASIC CARACTERISTICS OF BFT SYSTEMS
FACILITIES: SIZE, FORMAT, MATERIALS
THE USE OF MICROBIAL LOOP: BIOFLOC
NITRIFICATION PROCESS
HIGH PRODUCTION OF BACTERIAS
MANAGEMENT OF ALKALINITY/PH/CO2
HIGH CONCENTRATION OF TSS
AERATION SYSTEMS
USE OF VERTICAL SUBSTRATES
WATER MANAGEMENT
HIGH STOCKING DENSITIES
FEEDING MANAGEMENT
USE OF PROBIOTICS
LOW OR ZERO WATER EXCHANGE
REUSE OF WATER
DENITRIFICATION PROCESS
OTHERS

FARM MANAGEMENT: LESSONS FROM AFRICA AND ASIA

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Over the past decades, aquaculture research has made significant advances in areas such as nutrition, genetics, health, farming systems, and environmental interactions. However, the key to turning research into real value lies on the farm. Whether it is a new feed additive, an improved genetic strain, or the latest vaccine: innovations can only generate value when paired with strong farm management practices. Without effective farm management, investments in these innovations may yield only limited returns, if any.

As aquaculture is still a relatively young industry, knowledge on best farming practices remains fragmented. Jules Wehry is an Aquaculture Nutritionist at De Heus and previously worked as a farm manager for Yalelo Uganda. His career has taken him to major farming operations across aquaculture hotspots in Africa and Asia, including Ghana (Lake Volta), Zambia (Lake Kariba), Uganda (Lake Victoria), Egypt (Nile Delta), and Indonesia (Lake Toba).

During his presentation, Jules will share key lessons on farm management, focusing on:

- Site selection & water quality
- Fish handling & health
- Feed & feeding
- Record keeping & performance analysis
- Sales & value addition

For each topic, practical tips will be drawn from real-world examples of tilapia and catfish farming in both cages and ponds. This presentation offers valuable insights, not only for farm owners and managers, but also for farm input suppliers and researchers.

Farmers will gain practical knowledge to boost productivity, efficiency, and profitability. Meanwhile, suppliers and researchers will better understand which products and innovations can truly support farmers on the ground.

PROSPECT AND CHALLENGES IN THE FISHERIES VALUE CHAINS TRANSFORMATION IN ETHIOPIA, USING A COMMODITY SYSTEM APPROACH

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The primary purpose of this review was to examine fish production, aquaculture development, marketing, post-harvest practices, and consumption trends, along with key challenges facing the fisheries and aquaculture sub-sector in Ethiopia. The study also explored the enabling policy and institutional environment, with particular focus on integrating the sector within national agriculture, nutrition, and food security strategies. A mixed-methods approach was used to synthesize findings from both qualitative and quantitative data sources. An extensive literature review was conducted on empirical studies related to aquaculture development, inland capture fisheries, post-harvest handling and technology dissemination, fisheries economics, and regulatory frameworks. The fisheries and aquaculture value chains were analyzed using a unique cross-sectional dataset from major Ethiopian water bodies, including reservoirs and lakes in the Rift Valley and highlands such as lakes *Chamo*, *Tana*, *Ziway*, *Koka*, and *Hawassa*. In addition, time series data on fish and fishery product imports and exports, as well as price trends by product type, were compiled from the Ethiopian Revenue and Customs Authority, the Ministry of Agriculture, and the World Trade Map. The Living Standards Measurement Study (LSMS) dataset from the World Bank was used to assess changing patterns in fish consumption across income quintiles and regional states. Comparative insights into aquaculture practices and the fish marketing and regulatory environment were drawn from IGAD countries, particularly Uganda and Kenya. The study also provides mid-term projections on Ethiopia's fish demand and supply outlook, and highlights opportunities to scale aquaculture as a sustainable solution for improving nutrition and livelihoods.

TAPPING INTO THE GLOBAL ARTEMIA NETWORK: THE INTERNATIONAL ARTEMIA AQUACULTURE CONSORTIUM (IAAC)

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The brine shrimp *Artemia* is an important live food source for many aquatic animals used in aquaculture. The International Artemia Aquaculture Consortium (IAAC) was founded due to its strategic significance and has expanded into a large worldwide network comprising international development agencies, academic institutions, and industry stakeholders. It was recognized by the FAO Subcommittee on Aquaculture in 2023 and the IAAC secretariat is based at NACA in Bangkok.

This presentation focuses on how IAAC may facilitate knowledge exchange, capacity building, and sustainable production approaches, particularly in Asia and Africa. We will highlight successful cooperative strategies like breeding programs, technology transfer projects, and environmental management actions and discuss how partnerships, especially those among companies, universities, and governmental organizations, can address growing issues like climate resilience, biosecurity, and exploitation/use of Artemia. This presentation seeks to inspire broader network involvement and promote equitable growth in the aquaculture sector by highlighting excellent practices and ongoing efforts.

STUDY OF THE ZOOTECHNICAL PERFORMANCE OF CRAYFISH IN INTENSIVE REARING

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Faced with the stagnation of wild fish stocks, modern aquaculture is increasingly turning to intensive farming systems featuring high-value species. *Procambarus clarkii*, commonly known as the red swamp crayfish or Louisiana crayfish, has emerged as a promising candidate due to its resilience, rapid growth, and growing economic significance—particularly in China and Louisiana.

This study aimed to assess the zootechnical performance of *Procambarus clarkii* in intensive rearing conditions, focusing on key parameters such as growth, survival rate, moulting, and water quality. The experimental design involved 102 individuals divided into two cohorts, reared in controlled aquariums and semi-extensive pond systems. Weekly monitoring of physicochemical parameters (temperature, pH, oxygen, salinity) was conducted to maintain optimal rearing conditions, while morphometric data revealed progressive growth aligned with developmental stages.

Preliminary findings indicate that *Procambarus clarkii* holds significant potential for intensive aquaculture, provided that cannibalism, reproduction, and water quality are tightly managed. These insights support the sustainable expansion of crayfish farming—especially in resource-limited areas—while emphasizing the need for strict ecological oversight due to the invasive nature of the species.