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INVENTORY OF CLIMATE SMART AGRICULTURE TECHNOLOGIES, INNOVATIONS AND MANAGEMENT PRACTICES (TIMPs) FOR AQUACULTURE VALUE CHAIN

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KENYA CLIMATE SMART AGRICULTURE PROJECT (KCSAP)

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DISCLAIMER

The information presented in this inventory of Technologies, Innovations and Management Practices (TIMPs) book is for advisory use only. Users of this book should verify site specific details that relate to their agro-climatic zones from their area agricultural extension officers.

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FOREWORD

Kenya Climate-Smart Agriculture Project (KCSAP) tasked the Kenya Agricultural and Livestock Research Organization (KALRO) with the implementation of the project's Component 2 on 'Strengthening Climate-Smart Agricultural Research and Seed Systems'. The component activities are geared towards the development, validation, adoption and delivery of context specific climate smart agriculture (CSA) technologies, innovation and management practices (TIMPs). It is also responsible for development of sustainable seed production and distribution systems of priority agricultural value chains to enhance availability and access improved seeds, animal breeds and fingerlings by target beneficiaries. Against this background, KALRO and her National Agricultural Research System (NARS) partners have developed, validated and availed CSA TIMPs for dissemination and adoption. This document provides a detailed inventory of TIMPs that have been developed in Pastures and Fodders value chain.

Extensive information from research and background data has been used to develop this TIMPs inventory. To disseminate the TIMPs, a Training of Trainers (ToT) manual has been developed. The design of the manual takes into consideration the delivery system, partners and their roles, duration of training and logical flow of the modules. The training modules have uniform outline that ensures every aspect of the TIMPs are fully covered in way that the trainees can absorb and relate to. Various delivery methods are deployed and where possible demonstrations and practical work are incorporated to enable the trainees learn by participating in the actual field activities. The use of this TIMPs inventory is expected to contribute to achievement of the envisaged KCSAP's project 'Triple Wins' of increased productivity, enhanced resilience and reduction of greenhouse gases emissions. Thus, this TIMPs inventory is to be used in conjunction with the respective Dairy ToT Manual.

Finally, I am greatly indebted to the value chain leaders and all those who participated in the preparation of this inventory of TIMPs. It is expected to herald new ways of delivering training content that will enable realization of the project objectives and aspirations.

Eliud K. Kireger, PhD, OGW
Director General, KALRO

PREFACE

The Kenya Climate-Smart Agriculture Project (KCSAP) is a Government of Kenya project with support from both the World Bank and the government. The project runs for five years and implemented in 24 counties, mainly in the arid and semi-arid lands (ASALs), at an approximate cost of KES 25 billion. The project development objective (PDO) is "to increase agricultural productivity and build resilience to climate change risks in the targeted smallholder farming and pastoral communities, and in the event of an Eligible Crisis or Emergency, to provide immediate and effective response." This objective is to be achieved through the implementation of five key components, which are: 1) Upscaling Climate-Smart Agricultural Practices, 2) Strengthening Climate-Smart Agricultural Research and Seed Systems, 3) Supporting Agro-weather, Market, Climate, and Advisory Services, 4) Project Coordination and Management and 5) Contingency Emergency Response.

Component 1 involves facilitating the empowering of farmers and communities to adopt technologies, innovations and management practices (TIMPs) to achieve the Climate Smart Agriculture (CSA) triple-wins of; increased productivity, enhanced resilience (adaptation), and reduced Greenhouse gas (GHG) emissions (mitigation). Component 2 is tasked with the responsibility of providing the TIMPs. Therefore, it supports the development, validation, and adoption of context specific CSA TIMPs to target beneficiaries under Components 1 and 3.

To catalyze uptake of TIMPs, Kenya Agricultural and Livestock Research Organization (KALRO) in conjunction with partners in the National Agricultural Research Systems (NARS) and Consultative Group for International Agricultural Research (CGIAR) compiled inventories of TIMPs for the prioritized value chains. The livestock-based value chains are five and include apiculture, indigenous chicken (meat and eggs), dairy (cattle and camel), red meat (cattle, sheep and goats) and aquaculture. Also, there are three cross cutting thematic areas on pastures and fodder, natural resource management, and animal health. The crop-based value chains are 19 and include roots and tubers (cassava, potato), pulses (dry beans, green gram and pigeon peas), vegetables (tomato, onion, indigenous vegetables, kale and cabbage), cereals (sorghum, millet, maize, teff) nuts (Cashew nut), fruits (banana, mango, water melon) and fibre (cotton). The TIMPs have been categorized into those ready for upscaling and those requiring validation. Furthermore, gaps that required further research and development of TIMPs have been identified. Training of Trainers' (ToT) manuals focusing on TIMPs that are ready for upscaling for each of the value chains have been subsequently developed to form the basis of training county extension staff, service providers and lead farmers. Those trained are in turn expected to cascade the training to beneficiaries in the targeted smallholder farming, agro-pastoral and pastoral communities in the 24 project counties of Marsabit, Isiolo, Tana River, Garissa, Wajir, Mandera, West Pokot, Baringo, Laikipia, Machakos, Nyeri, Tharaka Nithi, Lamu, Taita Taveta, Kajiado, Busia, Siaya, Nyandarua, Bomet, Kericho, Kakamega, Uasin Gishu, Elgeyo Marakwet and Kisumu.

KALRO, having the responsibility of implementing the activities under Component 2, has been instrumental in using its information resources and those of partners and collaborators to come up with the inventories of TIMPs and corresponding ToT manuals. Use of these information resources coupled with the accompanying training

and contribution of the other project components will go a long way in enabling KCSAP to meet its development objectives.

The National Project Coordination Unit is grateful to all who participated in the development and production of this TIMPs inventory for Dairy Value Chain. It is my hope that counties and other users will put this resource to good use as they transform and reorient their agricultural systems to make them more productive and resilient while minimizing GHG emissions under the new realities of the changing climate.

Francis Muthami
National Project Coordinator
Kenya Climate-Smart Agriculture Project

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ABBREVIATIONS AND ACRONYMS

1.0 Introduction

1.1 Background Information

The Kenya Climate Smart Agriculture Project (KCSAP) is a Government of Kenya/World Bank supported project under the State Department for Crops Development in the Ministry of Agriculture, Livestock, Fisheries and Irrigation (MoALF&I). The Project Development Objective (PDO) is "to increase agricultural productivity and build resilience to climate change risks in targeted smallholder farming and pastoral communities in Kenya, and in the event of an Eligible Crisis or Emergency, to provide an immediate and effective response". This objective will be achieved through the utilization of climate-smart agriculture (CSA) technologies, innovations and management practices (TIMPs). Aquaculture is one of the best innovations for adaptation in agriculture to achieve food security under a changing climate while delivering co-benefits for environmental sustainability, nutrition and livelihoods[1]. Climate change present challenges for which CSA TIMPs are urgently needed.

The KCSAP Project aims to inventorise all CSA TIMPs in the Aquaculture Value Chain. Aquaculture offers great scope for technical innovation to further increase animal protein supply and resource efficiency. Aquaculture innovations include technologies that the diversify economy and food production, improve production efficiencies at the hatchery or farm levels while mitigating environmental impact; technologies that mitigate the occurrence of animal diseases or parasites, or that reduce or eliminate the use of antibiotics to treat animals; advances in land-based recirculation technology; novel feed ingredients; reductions in carbon footprint through improved energy efficiency or regeneration; and social programs designed to improve living and working conditions at the farm or processing levels[2]. Important efficiency gains can also be reached by reducing wastes and losses during production and post-harvest.

This document inventorise aquaculture technologies, innovations and management practices that have been adopted in Kenya. The Aquaculture TIMPs are grouped into five categories representing sustainable intensification, namely (a) culture systems, (b) fish breeding and genetics, (c) feeds and fish nutrition, (d) fish health and disease control, and (e) value addition techniques, post-harvest management, and marketing information systems.

1.2 Definition of Terms for Technologies, Innovations and Management Practices

1.2.1 Technology: Is an output of a research process which is beneficial to the target clientele (mainly farmers in our case). Technology can be commercialized and can be patented under intellectual property rights (IPR) arrangements. Examples include research outputs such as improved fish breeds, new vaccines, new equipment, etc.
1.2.2 Complementary Technology: Is any accompanying information on practice(s) that is (are) considered necessary for a technology to achieve its optimum output. Examples include

[1] Hambrey, J., 2017. The 2030 Agenda and the Sustainable Development Goals: The Challenge for Aquaculture development and management. FAO Fisheries and Aquaculture Circular No. 1141, Rome, Italy. http://www.fao.org/3/a-i7808e.pdf

[2] FAO, 2019. Aquaculture innovations, their upscaling and technology transfer to increase efficiency, combat environmental degradation and adapt to climate change. http://www.fao.org/3/na401en/na401en.pdf

routine aquaculture practices (liming rates, fertilizer application rates, pond and cage designs, etc.; and value addition protection methods; and, post-harvest handling techniques. Different feed rations/regimes, different management systems, disease control methods, etc.

NOTE: 'Complementary technology' is important information which is generated through research to accompany the parent technology before it is finally released to users and the technology would be incomplete without this information.

1.2.3 Innovation: Is a modification of existing technology for an entirely different use from the original intended use. It is also an application of new or existing knowledge/technology in a new way or context to do something better or different. An example is a narrow-deep lined or cemented pond for rearing catfish.

1.2.4 Information/Knowledge: This is generated by adaptation trials which are sitespecific. Technology can be acquired by a KMFRI Centre from outside the country, from other higher education centres/national research institutions or from CGIAR Centres and taken through adaptability trials to evaluate and fine-tune it to fit with the biophysical and socio-economic circumstances within the mandate areas of the KMFRI Centre. Examples include growth performance of improved seed strains in different ecological zones. The resulting recommendations are classified as knowledge since they enlighten the target clientele in the area on a certain best practice(s).

1.3 Summary of Inventory of TIMPs in Aquaculture Value Chain

The inventory process resulted in a total of **47 TIMPs** including 8 technologies, 4 complimentary technologies, 30 innovations, 5 pieces of information, distributed among the six sub-themes, as indicated in Table 1.

Table 1. Number of TIMPs identified by NARS in Aquaculture Value Chain

Commodity/VC	Sub-Theme	Technologies	Complementary Technology	Innovations	Information
Fish/Aquaculture	Breeding and Genetics	4	-	14	-
Fish/Aquaculture	Culture Systems	0	0	7	-
Fish/Aquaculture	Feeds and Feeding	1	2	3	-
Fish/Aquaculture	Fish Health and Biosecurity	0	1	4	-
Fish/Aquaculture	Post-harvest and Value Addition	2	1	2	-
Fish/Aquaculture	Market Linkages and Distribution	1	-	-	5
Total		**8**	**4**	**30**	**5**

1.4 Summary of Status of TIMPs in Aquaculture Value Chain

The inventory process resulted in a total of **36 TIMPs ready for upscaling**, **6 require validation and 5 require further research** in the sub-themes, as indicated in Table 2.

Table 2. Number of TIMPs ready for upscaling, require validation or further research

Commodity/VC	Sub-Theme	Ready for upscaling	Require validation	Further Research
Fish/Aquaculture	Breeding and Genetics	13	3	2
Fish/Aquaculture	Culture Systems	5	2	0
Fish/Aquaculture	Feeds and Feeding	5	0	1
Fish/Aquaculture	Fish Health and Biosecurity	4	0	1
Fish/Aquaculture	Post-Harvest and Value Addition	4	0	1
Fish/Aquaculture	Market Linkages and Distribution Channels	5	1	0
Overall Total		**36**	**6**	**5**

Table 3: Inventory of Aquaculture TIMPs, Categories, Status and Outputs for KCSAP

TIMPs SubTheme	TIMPs Title	TIMPs Category	Status
1. Culture Systems and Innovative Production Technologies	**1.1 Pond-based production systems**	Innovation	Ready for upscaling
	1.2 Recirculating aquaculture systems 1.2.1 Solar/wind-powered RAS systems 1.2.2 Aquaponics systems (IT driven)	 Innovation Innovation	 Require validation Require validation
	1.3 Integrated culture systems 1.3.1 Rice-fish culture systems 1.3.2 Crop-livestock-fish systems	 Innovation Innovation	 Ready for upscaling Ready for upscaling
	1.4 Water based systems 1.4.1 Low volume, high density (LVHD) and (HDPE) rectangular and circular cages in lakes and reservoirs	Innovation	Ready for upscaling
	1.5 Fish Aquarium for Ornamental fish	Innovation	Ready for upscaling
2. Fish Breeding, Reproduction and Genetics	2.1 **Improved Fish Breeds** 2.1.1 Improved Nile tilapia [F7-2017-01] 2.1.2 Improved Marine Tilapia 2.1.3 Improved Catfish Strain [F3-2017-01] 2.1.4 Development of YY super male Tilapia	 Innovation Innovation Innovation Technology	 Ready for upscaling Ready for upscaling Ready for upscaling Ready for upscaling

	2.2 Indigenous Fish Species **2.2.1 Indigenous Tilapiine species** e.g. Victoria tilapia *(Oreochromis variabilis),* Singida tilapia, *(Oreochromis esculentus),* Jipe tilapia, *(Oreochromis jipe)* **2.2.2 Indigenous African Barbs and Carps** e.g. Common barbel, *Barbus altianalis* and Ningu, *Labeo victorianus*	Innovation Innovation	Require further research Require validation
	2.3 Coastal aquaculture species 2.3.1 1Finfish e.g. Milk fish Chanos chanos 2.3.2 Red snapper 2.3.3 Shellfish e.g. Mud crab, *Scylla serrata* 2.3.4 Prawns, *Penaeus monodon*	Innovation Innovation Innovation Innovation	Ready for upscaling Ready for upscaling Ready for upscaling Ready for upscaling
	2.3.5 Seaweed *Kappaphycus alvarezii* "cottonii"	Innovation	Ready for upscaling
	Potential species under culture trials e.g. Lung fish, *Protopterus aethiopicus*	Innovation	Require further research
	2.5 Fish breeding techniques 2.5.1 Hormonal sex reversal 2.5.2 Artificial propagation of catfish 2.5.3 Temperature shock Tilapia & Goldfish 2.5.4 Production of sterile Tilapia stocks using plant extracts	Technology Technology Technology Innovation	Ready for upscaling Ready for upscaling Ready for upscaling Require validation
	2.6 **Model Mini Hatchery**	Innovation	Ready for upscaling
3. Fish Feeds and Feeding Management	**3.1 Biofloc technology**	Technology	Require further research
	3.2 Use of live feeds for larval rearing 3.2.1 Artemia 3.2.2 Rotifers	Complimentary Complimentary	Ready for upscaling Ready for upscaling
	3.3 Plant protein replacements for fishmeal in feed formulations (e.g. Fodder based protein, Seed cake and Fruit based protein	Innovation	Ready for upscaling
	3.4 Animal Based protein sources in fish diets as replacement for fishmeal (Insect based protein and worm-based protein)	Innovation	Ready for upscaling
	3.5 Feed Management Practices (Processing, Storage, and Feeding Strategies e.g. automated and non-automated Systems)	Innovation	Ready for upscaling

4. Fish Health and Biosecurity	**4.1 Prophylactic treatments** 4.1.1 Chemical treatment and Plant extracts as pesticides	Innovation	Ready for upscaling
	4.2 Therapeutics treatments e.g. Antibiotic application rates and Pesticides for disease control	Innovation	Ready for upscaling
	4.3 Use of Probiotics	Innovation	Require further research
	4.4 Biosecurity management practices e.g. Predator control, Disinfection units, Quarantine and Surveillance systems)	Innovation	Ready for upscaling
	4.5 Routine management practices e.g. liming, fertilization, and Water quality monitoring guidelines**)**	Complimentary	Ready for upscaling
5. Postharvest loss reduction and value addition	5.1 Smoking kiln	Technology	Ready for upscaling
	5.2 Mama Karanga"	Innovation	Ready for upscaling
	5.3 Value added products e.g. samosa, balls,	Complimentary	Ready for upscaling
	5.4 Improved Solar Driers	Technology	Ready for upscaling
	5.5 Nutrition based value added products e.g. Fish powders for infants "Boneless fish supplements"	Innovation	Require further research
6. Fish Market Linkages and Distribution Channels	6**.1 Web-based systems** e.g. Aquaculture Market Information Platform	Technology	Ready for upscaling
	6.2 Mobile based Apps e.g. KMFRI EFMIS and Aquaculture Info App	Information	Ready for upscaling
	6**.3 Social media** (WhatsApp & Facebook Closed Groups)	Information	Ready for upscaling
	6.4 Aquaculture Business Starter Kit	Information	Require validation
	6.5 Fish Branding, Eco labeling and Certification	Information	Require for upscaling
	6.6 Aquaculture Service and Inputs Providers Directory	Information	Ready for upscaling

2.0 Culture Systems And Innovative Production Technologies

2.1 Pond-based Aquaculture Production Systems

Technology name	Pond-based Aquaculture Production Systems
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem to be addressed	The bulk of Kenya's farmed fish production (>70%) originates from small-scale low productivity traditional farming systems. Poorly constructed ponds often result in lower production yields and incomes. This is because additional management efforts and associated costs are required to achieve higher yields. Therefore, paying attention to pond design and construction is the first step to successful pond production. A commercial fish pond is one of the several production units used in fish farming. A pond must be able to hold water and sustain favourable conditions for production.
What is it? (TIMP description)	Ponds are natural or artificial impoundments forming closed water bodies and mainly used for freshwater (rain-fed, irrigated, flowthrough) or brackish water aquaculture. Ponds are generally earthen, constructed by hand or machine. Pond farms can range in size from very small e.g., 0.05 ha to very large e.g., 200 ha; the critical factors in design being (a) the pond carrying capacity, (b) water quality and water volume control, (c) number of fish stocked. Pond production range from 0.25 ha to 1.5 ha for small-scale farmers and investors.
Justification	The typical smallholder aquaculture producers in Kenya, comprising the largest concentrations of aquaculture enterprises, operate low-input/low-output enterprises because of inadequate technical expertise of producers, input challenges (quality of fingerlings and feed or unaffordability of good quality ones), and inadequate marketing channels. Fish produced from ponds is a vital source of essential macro- and micronutrients for small-scale farmers and plays an important role in reducing the high prevalence of undernutrition in Kenya. Since land and water are becoming scarce for aquaculture due to competition from various sectors, several technological advancements have been promoted to achieve sustainable fish production.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, hatcheries, research institutions, training and capacity building institutions

Approaches to be used in dissemination	• Training of Trainer (ToT) Manual • Extension publications e.g. posters, leaflets, booklets, information sheets • On-farm practical demonstrations • Exchange visits to model farms • Training workshops/seminars
	□ Local radio and TV stations □ Agricultural shows and exhibitions □ Farmer-to-farmer communication.
Critical/essential factors for successful promotion	• Establish and strengthen existing aquaculture clusters and farmers groups, based on sound criteria and providing special focus for building their organizational skills; • Building the technical and business capacity of the project beneficiaries. • Increased awareness of the health benefits of fish consumption, changes in lifestyles and consumer preferences
Partners/stakeholders for scaling up and their roles	• Fish farmers to construct, upgrade or rehabilitate and stock ponds with fish in an environmentally sustainable manner. • National and County Governments to support farmers with matching grants to promote upscaling of commercial enterprises • National research institutes, extension agents, education and training institutes, universities, international research institutes and CGIAR to promote technical expertise of producers. • Non-governmental organizations (NGO) and civil society organizations e.g. Farm Africa, World Vision and (Inter)national agricultural/ aquaculture networks and associations, cooperatives, development organizations, donors to promote wider adoption of technologies
C: Current situation and future scaling up	
Counties where already promoted (if any)	Country-wide in counties that have great potential for aquaculture production (Migori, Kakamega, Homa Bay, Nyeri, Meru, Kirinyaga, Tharaka Nithi, Kisii, Kisumu, Siaya, Busia, Embu, Kiambu and Machakos).
Counties where TIMPs will be upscaled	Busia, Kakamega, Siaya, Kisumu, Nyandarua (target counties that prioritized fish value chain)
Challenges in dissemination	• Limited access to investment capital, especially for expansion of existing operations • At the County level, extension services are barely functional due to inadequate skilled extension service providers and lack of mobility and other resources needed for effective service provision • Inadequate research and technical expertise of producers, • Input challenges (quality of fingerlings and feed or unaffordability of good quality ones), and adequate marketing channels.

Suggestions for addressing the challenges	• There is need for intensified training/workshops for nursery operators, grow-out farmers and extension officers to the County level to have a fast and meaningful impact. • Allocation of more funds for continued research and dissemination to increase uptake and adoption of the Innovation.
	Enhanced collaboration with other NARS, Higher Education Institutions for upscaling the innovation and continued genetic improvement
Lessons learned in upscaling (if any)	Promotion of Public Private Producers Partnership (PPPP) schemes can enable small aquaculture farmers to achieve technical, economic and financial viability through increased productivity and delivering of quality fish products to the Kenyan population while making a significant surplus.
Social, environmental, policy and market conditions necessary for development and upscaling	• Enabling policy frameworks e.g. the Big Four Agenda and Vision 2030 flagship projects • Enhanced nutrition education programmes in Kenya, such as the Eat More Fish Campaign, have raised the awareness among non-fish-eating tribes on the benefits of fish consumption • Existence of suitable bio-physical environments in target counties. • Reliable markets for fish products sold from the systems and stable prices.
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Pond construction for a single 300m^2 pond: KShs 30,000 (Farmers typically provided some amount of unpaid labor. Fish feed: Average cost of KShs 100 per kg Fish fingerlings: KShs 5-10 per piece Manure and Lime: KShs 2,000 Equipment/netting: KShs 20,000
Estimated returns	Pond systems rely on supplemental or complete feeds to achieve profitable yields. Tilapia is the most common produced fish in ponds. Minimum acceptable yields are often in the neighborhood of 2 MT/ha [± 0.5 MT], whilst producers at the upper end of the scale report yields of three to four times this baseline depending on management and climatic factors.
Gender issues and concerns in development, dissemination, adoption and scaling up	• Wage disparity between men and women i.e. women receive lower returns and disproportionately less represented in lessprofitable nodes of fish value chain • Aquaculture is male dominated due to strong cultural norms that place male heads of households as decision-makers while women handle household chores • Men mainly involved in fish production while women handle the fish value addition, processing, marketing and trade • Women are also disadvantaged in their access to other types of aquacultural inputs, such as extension information and services and access to credit.

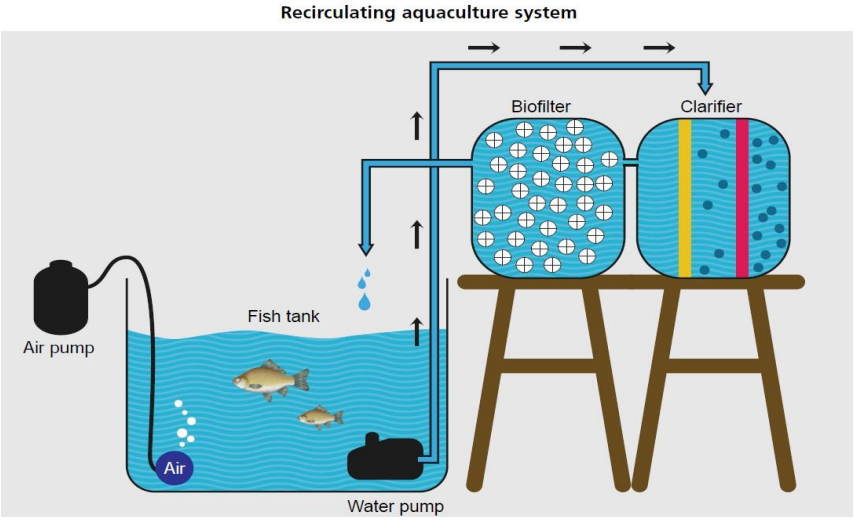
Gender related opportunities	• Improve women's equitable participation and protect their welfare and meet their strategic needs through the innovative technologies for increased extension, productivity and profitability. • Ensure that men, women and vulnerable/marginalized groups participate and benefit equitably under the project
VMG issues and concerns in development, dissemination, adoption and scaling up	- Due to prejudices associated with their social status, VMGs are excluded from access to and benefits from improved technologies. - Women get little returns due limited land ownership and deeprooted gender disparities in social, cultural and economic spheres. - Limited participation of women, youths and the elderly in aquaculture value chains - Inequitable distribution of aquaculture value chain incomes and benefits among the VMGs - Inadequate access to financial and capital resources and markets
VMG related opportunities	• Fish is a vital source of essential macro- and micronutrients; therefore, there is need to adopt affirmative action targeting the VMGs to reduce high prevalence of undernutrition in Kenya. • Production is labour intensive; thus, need for mechanization/labour saving interventions. • Enhance market linkages to trigger increased production.
E: Case studies/profiles of success stories	
Success stories from previous similar studies	• Pond aquaculture targeting smallholders was promoted heavily in the Economic Stimulus Programme (ESP) (2009-2013). • Prior to the ESP project in 2008, there were only 4,742 fish farmers countrywide with 7,530 fish ponds occupying 271 Ha. • The number of farmers increased tremendously to 49,050, with an estimated 69,998 ponds occupying 2,063 Ha at the peak of the subsidy program in 2012. • With supportive government policies and substantial public investments, aquaculture production in Kenya increased rapidly from <1000 tonnes in 2006 to 24,000 tonnes in 2013.
Application guidelines for users	Reference: KMFRI (2011) A Fish Farmer's Manual - For Beginners, Students and Hatchery Managers. Ngugu et al. (2007) New Guide to Fish Farming in Kenya
F: Status of TIMP readiness (1. Ready for upscaling; 2. Require validation; 3. Require further research)	Ready for upscaling
G: Contacts	
Contacts	Deputy Director, Aquaculture Division - Dr Jonathan Munguti Kenya Marine and Fisheries Research Institute (KMFRI) P.O. Box 451-10230, Sagana | kmfrinardtc@gmail.com

Lead organization and scientists	The project is being implemented by KMFRI as the lead institution. The lead scientists are Dr Jonathan Munguti, Dr Kevin Obiero, Ms Mary Opiyo, Ms Domitila Kyule, Cecilia Muthoni, Mr Jacob Abwao, Jane Fonda, Elijah Kembenya and Robert Ondiba
Partner Organizations	• Karatina University • University of Eldoret • South Eastern Kenya University
	Kenya Fisheries Service NGOs (Farm Africa, World Vision), CBOs and FBOs National and County Governments.

2.2 Recirculating Aquaculture Systems (RAS)

2.2.1 Recirculating Aquaculture Systems

Technology name	Solar/Wind Powered Recirculating Aquaculture Systems (RAS)
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	In Kenya, pond-based aquaculture production has registered depressed performance for the third consecutive year, with total fish production declining by 34% from 18,656 tonnes in 2015 to 12,356 tonnes in 2017. Pond-based culture systems require more land for expansion as well as large volumes of water for fish production. Water use by conventional land-based systems is also high. The discharge of nutrient rich wastewater from ponds can cause eutrophication, resulting in degradation of recipient aquatic ecosystems. The increasing scarcity of water due to climate change and competition for available water resources from irrigated agriculture and other industries hinders the expansion of aquaculture. Therefore, further expansion of aquaculture will depend on the application of improved systems that have minimal adverse environmental impacts and require less water and space.
What is it? (TIMP description)	Recirculating aquaculture systems (RAS) are closed and semiclosed systems that intensively cultivate fish and reuse a large proportion of treated culture water to reduce water consumption and the release of nutrients into the environment. In a RAS system (Figure 1), water is reused for the fish after a cleaning and a filtering process.

	 Figure 1: Shows how a recirculating aquaculture system works
Justification	RAS are designed to optimize space and water use and to reduce wastewater discharge. The systems reduce water consumption up to 90-99% and allow greater control over environmental and water quality conditions. By removing waste (uneaten food, excrement, and dead bacteria), RASs improve conditions for cultured fish, enhancing feeding efficiency and allowing for higher stocking densities than most aquacultural systems. Besides, the systems provide market benefits such as the ability to match seasonal supply and demand and to co-locate production with consumer demand and supply patterns.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Hatchery operators, research and training institutions for practical demonstration and capacity building, fish farmers in urban, periurban areas and water deficient areas.
Approaches to be used in dissemination	• Training of Trainer (ToT) Manual • Extension publications e.g. posters, leaflets, booklets, information sheets • On-farm and on-station practical demonstrations • Exchange visits to model farms • Training workshops/seminars • Local radio and TV stations • Agricultural shows and exhibitions • Farmer-to-farmer communication
Critical/essential factors for successful promotion	Five major issues should be addressed to promote RAS: (i) Optimal sales prices and market for the preferred fish species; (ii)Site selection including licences from authorities; (iii) System design and production technology; (iv) Work force including a technical manager and sales staff; and (v) Financing the complete project all the way to a running business.
Partners/stakeholders for scaling up and their	• Model fish farms to upscale the technology and innovations • National and County Governments to support farmers with matching grants to promote upscaling of commercial enterprises

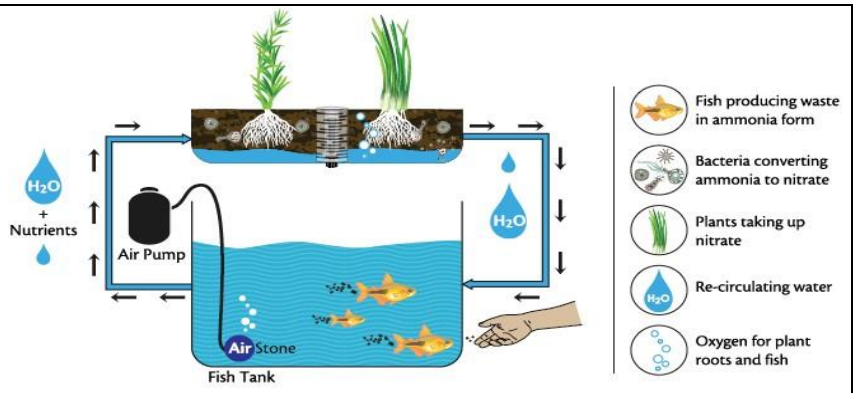
	• National research institutes, extension agents, education and training institutes, universities, international research institutes and CGIAR to promote technical expertise of producers. • Non-governmental organizations (NGO) and civil society organizations e.g. Farm Africa, World Vision and (Inter)national agricultural/aquaculture networks and associations, cooperatives, development organizations, donors to promote wider adoption of technologies • Aquaculture input suppliers to supply cost effective feeds, seed, equipment and tools • Aquaculture Association of Kenya (AAK) to promote networking among fish farmers and link them with other stakeholders in the aquaculture value chain.
C: Current situation and future scaling up	
Counties where TIMP already promote, if any	Kirinyaga, Machakos, Makueni, Nairobi and Nakuru Counties
Counties where TIMP will be upscaled	Busia, Kakamega, Siaya, Kisumu, Nyandarua
Challenges in dissemination	- Initial investment costs for RAS are relatively high. - Unsuitable initial designs of the system, poor management due to lack of skilled people, and high mechanical maintenance costs. - Aerobic biofilters are costly and require a reliable source of energy for continuous aeration to avoid anaerobic conditions. - Unreliable and expensive electricity supply
Suggestions for addressing the challenges	• Promote use of solar and wind energy as backup power solutions to high electricity costs • Encourage aquaculture equipment producers in Kenya to invest in the production of RAS equipment • To assist farmers cope with the relatively high initial investment costs for setting up the RAS system, governments could provide free-interest loan programs to fish farmers willing to implement RAS on their farms • Farmers implementing RAS expect a price premium for their product and higher yield to partially compensate for the high initial investments.
Lessons learned in upscaling if any	With RAS, the crucial parameters determining profitability are price, yield, costs of fingerling, feed, and initial investment. Findings on the robustness of the economic performance of RAS are useful to support public and private decision making towards increasing the sustainability of fish production.
Social, environmental, policy and market conditions necessary for development and upscaling	• Enabling policy frameworks e.g. the Big Four Agenda and Vision 2030 flagship projects • Enhanced nutrition education programmes in Kenya, such as the Eat More Fish Campaign, have raised the awareness among nonfish-eating tribes on the benefits of fish consumption • Existence of suitable bio-physical environments in target counties.

	• Reliable markets for fish products sold from the systems and stable prices.
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	To be determined
Estimated returns	The average weight of tilapia fish grown in ponds at one year is 300g. Using the RAS technology, fish weighs 400-500g at four months, thus fetching better prices. A kilo of fish fetches KSh 500.
Gender issues and concerns in development, dissemination, adoption and scaling-up	• Wage disparity between men and women i.e. women receive lower returns and disproportionately less represented in lessprofitable nodes of fish value chain • Aquaculture is male dominated due to strong cultural norms that place male heads of households as decision-makers while women handle household chores • Men mainly involved in fish production while women handle the fish value addition, processing, marketing and trade - Women are also disadvantaged in their access to other types of aquacultural
Gender related opportunities	• Increased production and sales results in increased incomes for both women and youth. • Women and youth could also benefit through access to credit and loan facilities • Huge potential for RAS in urban and peri-urban areas due to increased population, incomes and market for fish
VMG issues and concerns in development, dissemination, adoption and scaling up	- Due to high investment costs, VMGs are excluded from access to and benefits from RAS technology. - Women get little returns due limited land ownership and deeprooted gender disparities in social, cultural and economic spheres.
VMG related opportunities	• Increased production will lead to increased consumption of nutritious fish products, hence improved health of VMGs; high value of fish will lead to economic empowerment of VMGs. • Increased awareness on health benefits of fish and changing consumer behavior leading to increased fish demand hence improved incomes for VMGs
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Kamuthanga Fish Farm in Machakos is using Recirculating Aquaculture System (RAS) that halves fish maturity period from eight to four months thus enabling the farm to meet its market demands besides improving food security. RAS not only speed fish maturity but also increases fish weight. Fish weighs 400-500 grams at four months under the technology while in ponds the average weight of tilapia fish after a period of one year is 300 grams. Reference: http://www.farmbizafrica.com/advertise/14-markettrends/2014-farm-using-technology-to-speed-up-fish-maturityenhancing-market-linkages-and-sustainability
Application guidelines for users	Jacob Bregnballe (2015). A Guide to Recirculation Aquaculture: An introduction to the new environmentally friendly and highly

	productive closed fish farming systems. Published by the Food and Agriculture Organization of the United Nations (FAO) and EUROFISH International Organization
F. Status of TIMP readiness	Require validation
G: Contacts	
Contacts	Deputy Director, Head of Aquaculture - Dr Jonathan Munguti Kenya Marine and Fisheries Research Institute KMFRI P.O. Box 451-10230, Sagana Jmunguti2000@gmail.com
Lead organization and scientists	Kenya Marine and Fisheries Research Institute (KMFRI) Sagana Centre as the lead institution is implementing the technology. The lead scientists are Dr. Jonathan Munguti, Dr Kevin Obiero, Ms Mary Opiyo, Ms Domitila Kyule, Ms Jane Fonda, Ms Cecilia Muthoni, Mr Elijah Kembenya
Partner organizations	• Kamuthanga Fish Farm, Machakos County • County Governments, • Model fish farmers • RAS Equipment suppliers
	Aqualife Solutions Ltd Aquaculture Association of Kenya (AAK) Kenya Fisheries Service South Eastern Kenya University Other NARs and Feed development Centers in Kenya

2.2.2 Aquaponics systems

Technology name	**Aquaponics systems (IT driven)**
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem to be addressed	A major concern regarding the sustainability of modern agriculture is the complete reliance on manufactured, chemical fertilizers to produce food. These nutrients can be expensive and hard to source, and often come from environmentally harsh practices accounting for a substantial contribution of all carbon dioxide (CO_2) emissions from agriculture and aquaculture systems.
What is it? (TIMP description)	Aquaponics is the integration of recirculating aquaculture system (RAS) and hydroponics in one production system. In an aquaponic unit, water from the fish tank cycles through filters, plant grow beds and then back to the fish. In the system, water flows from the fish tank into a biofilter where bacteria break down the fish waste into an organic nutrient solution for the growing vegetables. The plants then absorb the nutrients from the water which essentially cleans it before being re-circulated back into the fish tanks (Figure 2).

	 Figure 2: Process of aquaponic operation (Source: Piccolo et al. 2019)
Justification	Aquaponics is a recirculating food production system that uses less than 10% of the water normally required for fish farming and plant production. Therefore, it is suitable for small-scale/domestic consumption as well as commercial organic food production, particularly in communities where water is scarce. There is very little water loss due to evaporation and plant transpiration. High-priced organic produce can be produced for urban markets, for instance. Aquaponics systems conserve water and plants growing in these systems grow quicker, larger and with a higher yield (15%) than those growing in a regular hydroponics system.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Input suppliers, women and youth groups, County Fisheries Departments, Kenya Fisheries Service, Research and Higher Learning Institutions and other schools.
Approaches to be used in dissemination	• Training of Trainer (ToT) Manual • Extension publications e.g. posters, leaflets, booklets, information sheets • On-farm and on-station practical demonstrations • Exchange visits to model farms • Training workshops/seminars • Local radio and TV stations • Agricultural shows and exhibitions
Critical/essential factors for successful promotion	• Fry production facility, on-site water-quality laboratory and extension services for fish disease identification and treatment • Optimal climate and environmental conditions for aquaponics • Access to good-quality fish fry, fingerlings and seeds/Seedling and aquaponic components • Access to electricity and quality water at the unit site at all times • Good experience with both aquaculture and horticulture methods • Equipment for effective large-scale, fish-solid-waste capture and biofiltration (swirl separators, clarifiers, etc.) • Biosecurity and integrated pest management protocols • Business plan including fish cost and market analysis
Partners/stakeholders for scaling up and their roles	• Fish farmers to construct, upgrade or rehabilitate and stock ponds with fish in an environmentally sustainable manner.

	• National and County Governments to support farmers with matching grants to promote upscaling of commercial enterprises • National research institutes, extension agents, education and training institutes, universities, international research institutes and CGIAR to promote technical expertise of producers. • Non-governmental organizations (NGO) and civil society organizations e.g. Farm Africa, World Vision and (Inter)national agricultural/aquaculture networks and associations, cooperatives. • Selected 4K club students in secondary and tertiary schools, service providers
C: Current situation and future scaling up	
Counties where already promoted. (if any)	Homa Bay, Kilifi, Kirinyaga, Kisii, Kitui, Laikipia, Machakos, Makueni, Meru, Nakuru, Nyeri, Muranga
Counties where TIMPs will be upscaled	Busia, Kakamega, Siaya, Lamu, Kisumu, Nyandarua (as prioritized by the target counties)
Challenges in dissemination	Inadequate extension and community outreach programs within the Counties Lack of extension and dissemination materials on aquaponics Lack of skilled operators with good practical knowledge
Suggestions for addressing the challenges	There is need for periodical training/workshops for aquaponic farmers, hobbyists, students interested in Agriculture and extension officers to the county level for fast and meaningful impact.
	• Allocation of more funds for continued research and dissemination to increase uptake and adoption of the innovation • Enhanced collaboration with other NARS, Higher Education Institutions for upscaling the innovation • Need to determine the most effective nontoxic pesticide to use it to control pests attacking the plants grown in the hydroponic
Lessons learned in upscaling (if any)	• Good filtration is key to the success of aquaponic systems • Less is often more, and simpler designs are often better more complicated designs are not always better, even though they look pretty. • Thoroughly test the market for each crop to determine salability and profit margin before diving into the deep end. • Nutrients that are lacking in the system can be supplemented in the feeds.
Social, environmental, policy and market conditions necessary for development and upscaling	• Supportive policies for economical production of either family food production or cash crops in many locations. • Reliable markets for organically produced fish and vegetables • Lower tax for expensive equipment during initial start-up compared with soil vegetable production or hydroponics
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Refer to FAO Technical Paper No 589
Estimated returns	Not et done. But costs varies according production system

Gender issues and concerns in development, dissemination, adoption and scaling up	• Wage disparity between men and women i.e. women receive lower returns and disproportionately less represented in less-profitable nodes of fish value chain • Aquaculture is male dominated due to strong cultural norms that place male heads of households as decision-makers while women handle household chores • Men mainly involved in fish production while women handle the fish value addition, processing, marketing and trade • Women are also disadvantaged in their access to other types of aquacultural
Gender related opportunities	Youth and women can establish sustainable aquaculture business enterprises which act as a source of income and livelihood
VMG issues and concerns in development, dissemination, adoption and scaling up	• Disempowerment of women in aquaculture value chains • Limited participation of women, youths and the elderly in aquaculture value chains • Inequitable distribution of aquaculture value chain incomes and benefits • Inadequate access to financial and capital resources and markets
VMG related opportunities	The VMG can establish aquaculture enterprises to generate income and livelihood
E: Case studies/profiles of success stories	
Success stories	Aquaponics is suitable for several fish species e.g. tilapia, common carp, trout, and a huge range of plants such as tomatoes, cucumbers, lettuce and green leafy vegetables, high priced herbs and others. Tilapia is most commonly used since they grow fast relative to other farmed fish (i.e. salmon, trout) and can tolerate poor water quality.
Application guidelines for users	**FAO Fisheries and Aquaculture Technical Paper No. 589.** 2014. Small-scale aquaponic food production. Integrated fish and plant farming. Rome, FAO. 262 pp. **SmartFish Leaflet No. 9.** Aquaponics – a smart fish-based solution to growing food using limited resources and little water. Prepared by: Antonio Piccolo, Chris Short and Christophe Sommerville
F: Status of TIMP readiness	Require validation
G: Contacts	
Contacts	Prof. Julius Manyala/ Josiah Ani University of Eldoret P.O. Box 1125-30100, Eldoret anijos03@gmail.com
Lead organization and scientists	The project is being implemented by University of Eldoret and KMFRI as lead institutions. The lead scientists are Dr Jonathan Munguti, Dr Kevin Obiero, Prof. David Liti, Prof Julius Manyala and Josiah Ani
Partner Organizations	• Karatina University • South Eastern Kenya University • Kenya Fisheries Service • National Aquaculture Research and Development Training Centre • County Governments.

2.3 Integrated Culture Systems

2.3.1 Rice-Fish Culture Systems

Innovation Name	Rice-fish culture systems
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem to be addressed	For increased food production, there is need for vast tracts of land for rice cultivation and water bodies for fish cultivation, which is very limited in Kenya with population of close to 50 million. Due to lack of sufficient technical knowledge and training on improved rice-fish culture which is expanding every day, many farmers are not getting optimum results in production.
What is it? (TIMP description)	A rice-fish system is an integrated rice field or rice field/pond complex, where fish are grown concurrently or alternately with rice. Fish may be deliberately stocked (fish culture) or may enter fields naturally from surrounding water ways when flooding occurs (rice field fisheries), or a bit of both. Fish yields can range widely from of 1.5 to 174 kg/ha/season depending on the type of rice fish system, the species present, and the management employed.
Justification	Due to limited land and water resources in Kenya, it is necessary to use same plot of land in multiple ways. Rice-fish culture is the system of cultivation of different crops in the same field at the same
	time, where the maximum use of land is ensured while maintaining ecological balance and achieving economical benefit. Moreover, by dyke cropping there are opportunities for farmer to fulfill nutritional demand of the family as well as an opportunity to earn excess money.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Fish farmers in rice growing regions (Busia and Kisumu Counties), Input suppliers e.g. hatcheries and feed producers, rice farmers
Approaches to be used in dissemination	• Training of Trainer (ToT) Manual • Extension publications e.g. posters, leaflets, booklets, information sheets • On-farm and on-station practical demonstrations • Exchange visits to model farms • Training workshops/seminars • Local radio and TV stations • Agricultural shows and exhibitions

Critical/essential factors for successful promotion	• There are four physical improvements that are commonly made to prepare rice fields for fish culture. • First is to increase the height of the dike to allow deeper water inside the field and/or to minimize the risk of it being flooded. • Second is the provision of weirs or screens to prevent the fish from escaping as well as keeping predatory fish from coming in with the irrigation water. • Third, which is not always practiced but often recommended, is provision of proper drains and • Fourth is the provision of deeper areas as a refuge for the fish
Partners/stakeholders for scaling up and their roles	• Model fish farms to upscale production of fish in rice fields • National and County Governments to support farmers with matching grants to promote upscaling of rice-fish farming • National research institutes, extension agents, education and training institutes, universities, international research institutes and CGIAR to promote technical expertise of producers. • Non-governmental organizations (NGO) and civil society organizations e.g. Farm Africa, World Vision and (Inter)national agricultural/aquaculture networks and associations, cooperatives, development organizations, donors to promote wider adoption of technologies • Aquaculture input suppliers to supply cost effective feeds, seed, equipment and tools • Aquaculture Association of Kenya (AAK) to promote networking among fish farmers and link them with other stakeholders in the aquaculture value chain.
C: Current situation and future scaling up	
Counties where already promoted, if any	Kirinyaga and Kisumu
Counties where TIMPs will be upscaled	Busia, Kisumu, Siaya, Kakamega, Nyandarua Counties
Challenges in dissemination	- Limited knowledge in operating integrated fish-rice establishment
	- Lack of guidelines on the nutrient balance and carrying capacities. - Probability of transferring diseases within the culture facility
Suggestions for addressing the challenges	• Develop guidelines on nutrient balance and carrying capacity of integrated systems. • Development of a business model on the most economic integration model and optimal sizes for optimal returns
Lessons learned	Modernizing integrated systems to attract youth and women groups in investments
Social, environmental, policy and market conditions necessary	Organized registered groups, zero rated cost of fish and rice, Reliable markets for improved fish breeds products and stable prices
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	To be determined
Estimated returns	To be determined

Gender issues and concerns in development, dissemination, adoption and scaling-up	• Wage disparity between men and women i.e. women receive lower returns and disproportionately less represented in lessprofitable nodes of fish value chain • Aquaculture is male dominated due to strong cultural norms that place male heads of households as decision-makers while women handle household chores • Men mainly involved in fish production while women handle the fish value addition, processing, marketing and trade • Women are also disadvantaged in their access to other types of aquacultural
Gender related opportunities	Production of fingerlings, sales and distribution of rice.
VMG issues and concerns in development, dissemination, adoption and scaling up	- Disempowerment of VMGs in aquaculture value chains - Limited participation of women, youths and the elderly in aquaculture value chains - Inequitable distribution of aquaculture value chain incomes and benefits - Inadequate access to financial and capital resources and markets
VMG related opportunities	Establishment of integrated aquaculture enterprises to act as a source of income and improved livelihood
E: Case studies/profiles of success stories	
Success stories	Few but successful famers in the rice growing counties have embarked in rice-fish integrated aquaculture systems as a better way to utilize space and maximize on return from farms
Application guidelines for users	Training manual on improved rice-fish culture and dyke cropping Development of booklets, brochure ad posters to simplify the ricefish integrated system
F: Contacts	
Contacts	Dr. Jonathan Munguti Kenya Marine and Fisheries Research Institute KMFRI P.O. Box 451-10230, Sagana Jmunguti2000@gmail.com
Lead organization and scientists	Kenya Marine & Fisheries Research Institute (KMFRI) Sagana Centre as the lead institution is implementing the project.
	The lead scientists are Dr. Jonathan Munguti, Prof Liti, Ms Mary Opiyo, Dr Kevin Obiero, Ms Domitila Kyule, Ms Jane Fonda, Josiah Ani
Partner organizations	County Governments, cottage feed producers, model farmers • University of Eldoret • Aquaculture Association of Kenya (AAK)

Gaps

1. Mass production of fingerlings
2. Nutritional requirements
3. Evaluation of best culture systems

2.3.2 Crop-Livestock Fish Systems

Innovation Name	Crop-Livestock-Fish Systems
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem to be addressed	There is low adoption and application of integrated crop, livestock and fish technologies despite many decades of research and development programs. Due to water scarcity and gradual shrinking of land holding in Kenya, it is essential to integrate land based enterprises such as crops, poultry, livestock, and horticultural crops within the bio-physical and socio-economic environment of fish farming.
What is it? (TIMP description)	Integrated farming is the "concurrent or sequential linkages between two or more human activity systems, one or more of which is aquaculture, directly on-site, or indirectly through off-site needs and opportunities, or both". The basic idea of crop-livestock-fish (CLF) is that wastes from other activities (e.g., crop residues, livestock manure and by-products) are used as feed/pond fertilizer, and fish wastes are recycled back into the system to fertilize crops.
Justification	Integration of crops, livestock and fish (CLF) holds considerable potential for augmenting production of high-value animal protein, generation of employment opportunities and improvement of socioeconomic conditions of rural small holder farmers. An output from one subsystem in an integrated farming system, which otherwise may have been wasted, becomes an input to another subsystem resulting in a greater efficiency of output of desired products from the land and water under a farmers' control thus increasing farmers' food and income security.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Hatchery operators, fish farmers in densely populated regions – limited land (Kiambu, Kisii) Fish farmers living in city suburbs (Kitengela, Thika, Ngong Kiserian)
Approaches used in dissemination	Farmer to former, mass media, practical demonstration, print media, model farmers
Critical/essential factors for successful promotion	PPP model, Good Aquaculture practices (GAqPs) in Integrated fish farming systems, Capacity building for integrated fish farming model farmers and extension officers Simple guidelines in integrated fish farming models
Partners/stakeholders for scaling up, their roles and stage of involvement	• Smallholder farmers for upscaling • Higher education institutions for capacity building • County Governments for upscaling • Private Model fish farms to invest in the technology • Kenya Fisheries Service (KeFS) • Aquaculture Association of Kenya (AAK) to disseminate information

C: Current situation and future scaling up	
Counties where already promoted if any	Kirinyaga, Machakos, Makueni, Nyeri, Kilifi, Embu, Garissa, Kitui, Kisii, Kiambu, Kajiado
Counties where TIMP will be upscaled	Busia, Kakamega, Siaya, Lamu, Marsabit, Kisumu, Nyandarua
Challenges in dissemination	Limited knowledge in operating integrated fish - livestock establishment, lack of guidelines on the nutrient balance and carrying capacities. Probability of transferring diseases within the culture facility
Suggestions for addressing the challenges	• Five model integrated systems (Fish-Chicken, Fish –Rabbits, Fish-dairy, Fish- ducks, fish -Guinea fowl) has successfully been tested and ready for upscaling • Develop guidelines on nutrient balance and carrying capacity of integrated systems. • Development of a business model on the most economic integration model and optimal sizes for optimal returns
Lessons learned in upscaling if any	Modernizing and commercializing integrated systems to attract youth and women groups in investments
Social, environmental, policy and market conditions necessary for development and upscaling	Organized registered groups, zero rated cost of fish and livestock feeds Reliable markets for improved fish breeds products and stable prices
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	
Estimated returns	Estimated returns depend on the magnitude of the established of integrated systems and the combination of the used organisms (birds, dairy etc.)
Gender issues and concerns in adoption and scaling-up	• Wage disparity between men and women i.e. women receive lower returns and disproportionately less represented in lessprofitable nodes of fish value chain • Aquaculture is male dominated due to strong cultural norms that place male heads of households as decision-makers while women handle household chores • Men mainly involved in fish production while women handle the fish value addition, processing, marketing and trade Women are also disadvantaged in their access to other types of aquacultural
Gender related opportunities	Integrated innovation is user friendly for women and youth groups and is a growing practice specifically by women living in highly densely populated regions (Kiambu, Nyeri, Kisii)Youth and women groups are opening and operating Integrated systems as business ventures
VMG issues and concerns in development and dissemination	Aquaculture is an important source of food production in Kenya, however its income, food, and other benefits are not evenly accessible to, nor distributed between women, youths and men of different age and social groups who engage in and depend on it.

VMG related opportunities	Empowerment of VMGs through provision of finance and production facilities The VMG can establish integrated aquaculture enterprises to act as a source of income and improved livelihood
E: Case studies/profiles of success stories	
Success stories	Many famers in the densely populated counties have embarked in integrated aquaculture systems as a better way to utilize limited space and maximize on return from farms
Application guidelines for users	Development of training manuals, guidelines, fact sheets, booklets brochure to simplify the manning of integrated system and maximize on profits
F. Status of TIMP Readiness	Ready for upscaling
G: Contacts	
Contacts	Dr Jonathan Munguti Kenya Marine and Fisheries Research Institute KMFRI P.O. Box 451-10230, Sagana Jmunguti2000@gmail.com
Lead organization and scientists	Kenya Marine & Fisheries Research Institute (KMFRI) Sagana Centre as the lead institution is implementing the project. The lead scientists are Dr. Jonathan Munguti, Ms Mary Opiyo, Dr Kevin Obiero, Ms Domitila Kyule, Ms Jane Fonda,
Partner organizations	County Governments, cottage feed producers, model farmers • Aquaculture Association of Kenya (AAK) • KALRO - Naivasha • Kenya Fisheries Service (KeFS) • South Eastern Kenya University (SEKU) • National Aquaculture Research and Development Training Centre (NARDTC)

2.4 Water-based Culture systems (LVHD Fish Cages)

Technology name	**Low Volume, High Density (LVHD) Fish Cages**
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	Although natural fish stocks in Lake Victoria and other major water bodies are declining from overfishing among other factors, demand for fish protein has been on a gradual increase because of rapid human population growth and awareness of benefits of eating fish. Large- scale cages can easily support an industry producing 10,000
	tonnes per year (t/yr) without any noticeable environmental impact, if regulated and managed properly.
What is it? (TIMP description)	Small cages, often called, low volume, high density cages (LVHD), have been promoted as a suitable farming. They are now being used by both small-scale and commercial farmers for growing tilapia. Large cage systems have not been developed so far in Kenya,

	however they are in widespread use all over the world. The production volume from small cages are estimated at 1,000 t/yr production and Large cage grow - out of tilapia (5,000 t/yr production)
Justification	Cage farming has many advantages over other methods of fish culture, including: very high production per unit volume of water; relatively low investment per unit of production; the anticipated high profitability levels; the use of existing water bodies thus reducing the pressure on land; the requirements of relatively low capital outlay; the ease of movement and relocation; the reduced effect of drought on production in relation to the availability of water; and the flexibility of management.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Cage farmers, Fish farmers, County Governments,
Approaches used in dissemination	• Training of Trainer (ToT) Manual • Extension publications e.g. posters, leaflets, booklets, information sheets • On-farm and on-station practical demonstrations • Exchange visits to model farms • Training workshops/seminars • Local radio and TV stations Agricultural shows and exhibitions
Critical/essential factors for successful promotion	• All cage culture operations should be subjected to environmental impact assessment/annual environment audits. • Cage culture operators should keep and provide records for their operations to the relevant authorities. • Cage fish handling and processing shall abide by the National and Regional HACCP procedures with emphasis on fish quality and safety. • Products should be clearly marked/labeled. • Farmed products should have separate processing facilities from capture products.
Partners/stakeholders for scaling up	• Cage farmers to install and stock cages in an environmentally sustainable manner. • National and County Governments to support cage farmers with matching grants to promote upscaling of commercial enterprises • National research institutes, extension agents, education and training institutes, universities, international research institutes and CGIAR to promote technical expertise of cage producers. • Non-governmental organizations (NGO) and civil society organizations to invest in sustainable intensification of cages
	□ (Inter)national agricultural/aquaculture networks and associations, cooperatives to promote investment and marketing of fish products.
C: Current situation and future scaling up	
Counties where already promoted, if any	Busia, Kisumu, Homa Bay, Migori, Siaya

Counties where TIMP will be upscaled	Busia, Siaya, Kisumu, Lamu
Challenges in dissemination	• Lack of skilled operators with good practical knowledge • Unfavorable business environment due to importation of cheap tilapia fish • Weak implementation of legal frameworks and cage guidelines • Inadequate readily available and affordable quality fish seed • Inadequate good quality and affordable fish feeds
Suggestions for addressing the challenges	• With increasing number of cages in the lake, there is need for policy and regulations to guide its investment to ensure environmental sustainability due to high likelihood of water quality deterioration in cage culture sites. • Implementation of national and regional cage culture guidelines to address conflicting interests in resource sharing, introduction of exotic culture species, disease and parasite invasion, establishment of aquaparks, and maximum carrying capacity. • Policy reviews to zero-rate cage culture equipment to promote investors to expand cage culture
Lessons learned in upscaling, if any	Domesticating cages made of locally available materials Great potential also lies in large- scale fish farms. Such farms would also need to be able to identify profitable market opportunities, but a second key need is to be sure that their investments are secure.
Social, environmental, policy and market conditions necessary	Organized registered groups, zero rated cost of feed ingredients Reliable markets for improved fish breeds products and stable prices
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Refer to Status of Cage Culture in Lake Victoria, Kenya. KMFRI Research Report No. AQUA/ FWS/2017–2018/5.
Estimated returns	Refer to State of cage culture for different categories of cage culture production i.e. semi-intensive and intensive production
Gender issues and concerns in development, dissemination, adoption and scaling-up	• Lack of access to financial and capital resources and markets • Limited access to credit and loan facilities for women & youths • Limited knowledge, skills and technologies and extension services • Limited evidence on women's participation and gender relations in the input sectors in general (feed, seed). • Limited understanding of policies that result in gendered inclusion or exclusion.
Gender related opportunities	Gender equity in provision of targeted information, practical demonstration, capacity building to all stakeholders on the application of innovation
	Youth and women groups can be supported to establish cage culture operations along the riparian counties
VMG issues and concerns in development, dissemination and upscaling	The Vulnerable and Marginalized Groups requires financial support to set up cage operations.

VMG issues and concerns in adoption and scaling up	• Unequal distribution of incomes and other benefits between women and men of different age and social groups who engage in and depend on aquaculture. • Due to high investment costs in cage culture, VMGs are excluded from access to and benefits from the technology. • Women and youths receive little returns due to deep-rooted gender disparities in social, cultural and economic spheres
VMG related opportunities	The VMG can partner with county governments to set up cage culture operation to act as a source of income and improved livelihood
E: Case studies/profiles of success stories	
Success stories	Cage culture has emerged from relative obscurity in the last 5 years as an important source of fish supply to consumers in rural and urban areas. Currently, there are 4,500 cages on the Kenya portion of Lake Victoria estimated to produce 5,000 tonnes of Nile tilapia per year.
Application guidelines for users	Development of cage training manuals, cage guidelines, suitability maps, fact sheets, booklets and posters to simplify cage operations
F. Status of TIMP readiness	Ready for upscaling
F: Contacts	
Contacts	Dr Kevin Obiero Kenya Marine and Fisheries Research Institute KMFRI P.O. Box 136-40111, Pap-Onditi kevobiero@gmail.com
Lead organization and scientists	Kenya Marine & Fisheries Research Institute (KMFRI) Sagana Centre as the lead institution is implementing the project. The lead scientists are Mr Elijah Kembenya, Dr. Jonathan Munguti, Dr Paul Orina, Ms Cecilia Muthoni, Ms Safina Musa, Mr Jacob Abwao, Robert Nyakwama
Partner organizations	County Governments, cottage feed producers, model farmers Aquaculture Association of Kenya (AAK) Kenya Fisheries Service National Aquaculture Research and Development Training Centre Other NARs and Feed development Centers in Kenya

2.5 Fish Aquarium for Ornamental fish

Technology name	**Fish Aquarium for Ornamental fish**
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem to be addressed	The ornamental fish sector is an extensive and global component of international trade, fisheries, aquaculture and development. However, the scope of this sector and the impact on human and
	aquatic communities are often unappreciated and often not accurately known. Farmers rearing ornamental fishes sell their fishes to middle men who offer very low prices for the fish commodity. Farmers have never invested in the aquarium making

	ventures. There is therefore a need to know how they are made, stocked, decorated, installed and managed.
What is it? (TIMP description)	An aquarium is a water-filled tank of any size having at least one transparent side in which aquatic plants or animals are kept and displayed. Most aquaria consist of glass panes bonded together by 100% silicone sealant, with plastic frames attached to the upper and lower edges for decoration. Aquaria can be locally fabricated using transparent glasses, clear plastic boxes and clear molded fiber glasses. 
Justification	Aquarium keeping is amongst the most popular of hobbies with millions of enthusiasts worldwide. With the increasing population of human being especially in urban centers, land has become scarce and ornamental fish industry is seen as one of the things to address this need. This has seen hobbyists investing heavily in this industry.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, seed suppliers, women and youth groups, Research and Higher Learning Institutions
Approaches to be used in dissemination	• Training of Trainer (ToT) Manual • Extension publications e.g. posters, leaflets, booklets, information sheets • On-farm and on-station practical demonstrations • Agricultural Trade fairs and exhibitions
Critical/essential factors for successful promotion	• Equipment for effective small-scale aquarium • Biosecurity and integrated pest management protocols • Design simple to complex aquaria that farmers can adopt and reproduce • Good management of aquaria and the fishes stocked inside
Partners/stakeholders for scaling up and their roles	• Fish hobbyists to design, construct and stock aquariums with ornamental fish in an environmentally sustainable manner. • National research institutes, extension agents, education and training institutes, universities, international research institutes and CGIAR to promote technical expertise of producers. • Non-governmental organizations (NGO) and civil society organizations to mobilize funds for common interest groups • (Inter)national agricultural/aquaculture networks and associations, cooperatives to market ornamental fishes and aquarium.
C: Current situation and future scaling up	
Counties where already promoted. (if any)	Homa Bay, Kilifi, Kirinyaga, Kisii, Kitui, Laikipia, Machakos, Makueni, Meru, Nakuru, Nyeri, Muranga

Counties where TIMPs will be upscaled	Busia, Kakamega, Siaya, Lamu, Kisumu, Nyandarua (as prioritized by the target counties)
Challenges in dissemination	Inadequate extension and community outreach programs within the Counties
Suggestions for addressing the challenges	• Need for more training and workshops to address feeding, breeding, colour enhancement challenges • Allocation of more funds for continued research and dissemination to address low intensity of hue in most aquarium fishes • Enhanced collaboration with other NARS, Higher Education Institutions for upscaling the innovation and continued genetic improvement of the ornamental fishes
Lessons learned in upscaling (if any)	• Fishes feed on feeds with 1-2% carotenoid containing diets • Poor water quality results in poor growth and high mortalities • There is demand for affordable aquaria in urban centers
Social, environmental, policy and market conditions necessary for development and upscaling	• Best management practices and environmental impact assessment/audit • Reliable markets for fish products sold from the systems and stable prices. • Availability of cheap materials and equipment for making aquariums
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Fishes sold per inch: The prices depend on the type of fish species but ranges from KES 20-100 per inch and not per fish
Estimated returns	Varies according production system (Excel Table to be developed for cost calculations)
Gender issues and concerns in development and dissemination	This innovation dissemination process ensured at least 50% representation of women, youth and vulnerable groups in decisionmaking processes; and provision of targeted information, education, capacity building to all stakeholders regarding gender awareness as well as on HIV, nutrition and related social aspects.
Gender issues and concerns in adoption and scaling up	The innovation can easily be taken up by women and youth groups
Gender related opportunities	Youth and women can establish sustainable aquaculture business enterprises which act as a source of income and livelihood
VMG issues and concerns in development and dissemination	This is an innovation that can be easily carried out by Vulnerable and Marginalized Groups
VMG issues and concerns in adoption and scaling up	The uptake by VMG is still low
VMG related opportunities	The VMG can establish aquaculture enterprises to generate income and livelihood
E: Case studies/profiles of success stories	
Success stories	There are an estimated 25 ornamental fish farmers in kenya. In 2013, a total of 20,649 pieces worth U$ 10,490 were exported from Kenya. The main exporting countries are Israel, Singapore, and

	Thailand. Small scale farmers e.g. Green Algea AquaFarm in Kirinyaga County owned by Mr William Kiama is involved in breeding of ornamental fishes. The farmer sells ornamental fish in domestic and export markets some to the neighbouring countries. The projected income is KES 100,000 weekly from the sale of this fishes and gate fees
Application guidelines for users	There is need for training manuals and guidelines
F: Status of TIMP readiness	Ready for upscaling
G: Contacts	
Contacts	Centre Director, Sagana Aquaculture Centre Kenya Marine and Fisheries Research Institute KMFRI P.O. Box 451-10230, Sagana kmfrinardtc@gmail.com
Lead organization and scientists	The project is being implemented by KMFRI Sagana Centre as the lead institution. The lead scientists are Dr Jonathan Munguti, Dr Kevin Obiero, Ms Mary Opiyo, Ms Domitila Kyule, Cecilia Muthoni, Mr Jacob Abwao, Jane Fonda, Elijah Kembenya and Robert Ondiba
Partner Organizations	• Karatina University • University of Eldoret • South Eastern Kenya University • Kenya Fisheries Service • National Aquaculture Research and Development Training Centre • County Governments.

3.1 Fish Breeding, Reproduction and Genetics

3.1.1 Improved Nile tilapia [F7-2017-01]

Technology name	Improved Nile tilapia [F7-2017-01]
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem to be addressed	Lack of certified quality fish seed and breed in small-scale aquaculture enterprise is often constrained by the stunted growth and low survival lead to poor yields and low uptake of fish farming across the country.
What is it? (TIMP description)	F7 is an improved strain of Nile tilapia that has undergone selective breeding. It attains better growth compared to wild stocks, uses less feed, and has improved flesh, bone ratio and high survival rate.

Justification	Demand for fish and fish products is increasing rapidly in Kenya and is driven by population and income growth, increased awareness of the health benefits of fish, consumption and changes in lifestyles and consumer preferences. While wild capture fisheries presently remain the dominant supplier of fish in Kenya,
	aquaculture is projected to play an important role in sustaining fish protein supply to meet increasing demand by 2030. Therefore, if improved policies and better technologies are adopted, producers can become more involved, with related benefits for environmental sustainability, consumer empowerment and wealth creation.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Input suppliers, Model authenticated hatcheries, Women and youth groups, County Fisheries Departments, Kenya Fisheries Service, Research and Higher Learning Institutions
Approaches to be used in dissemination	• Training of Trainer (ToT) Manual • Extension publications e.g. posters, leaflets, booklets, information sheets • On-farm and on-station practical demonstrations • Exchange visits to model farms • Training workshops/seminars • Local radio and TV stations Agricultural shows and exhibitions
Critical/essential factors for successful promotion	• Fry production facility and extension services for fish disease identification and treatment • Availability of good-quality Broodstock, fry, and fingerlings • Equipment for effective large-scale, fish-solid-waste capture and biofiltration (swirl separators, clarifiers, etc.) • Biosecurity and integrated pest management protocols • Business plan including fish cost and market analysis • Develop a decentralized breeding PPP model to increase access to improved breed stocks • Best Management Aquaculture Practices
Partners/stakeholders for scaling up and their roles	• Fish farmers to access and produce improved fish in an environmentally sustainable manner. • National and County Governments to support farmers with matching grants to promote upscaling of commercial enterprises • National research institutes, extension agents, education and training institutes, universities, international research institutes and CGIAR to promote technical expertise of producers. • Non-governmental organizations (NGO) and civil society organizations e.g. Farm Africa, World Vision • (Inter)national agricultural/aquaculture networks and associations, cooperatives. • Multipliers / Hatcheries to take up the improved breeds for multiplication and avail to farmers

	• Engagement of county governments to take up the technology and avail it to farmers for improved livelihoods—food and nutrition security, poverty alleviation and income generation.
C: Current situation and future scaling up	
Counties where already promoted. (if any)	Homa Bay, Kilifi, Kirinyaga, Kisii, Kitui, Laikipia, Machakos, Makueni, Meru, Nakuru, Nyeri, Muranga
Counties where TIMPs will be upscaled	Busia, Kakamega, Siaya, Lamu, Kisumu, Nyandarua (as prioritized by the target counties)
Challenges in dissemination	Inadequate extension and community outreach programs within the Counties
Suggestions for addressing the challenges	• There is need for intensified Good Aquaculture Practices training for hatchery operators, grow-out farmers and extension officers to the county level for fast and meaningful impact. • Improve KMFRI capacity to produce Broodstock and parental stock • Allocation of more funds for continued research and dissemination to increase uptake and adoption of the technology. • Enhanced collaboration with other NARS, Higher Education Institutions for upscaling the technology and continued genetic improvement
Lessons learned in upscaling (if any)	For increased yields to be realized from improved seed production, there is need to adopt a three-pronged approach [i.e. quality seed + quality feed + best management practices=higher yields]. Quality and affordable feed and water quality management should be enhanced for the improved seed production to realize growth and survival performance experienced at the research trials and well operated private farms.
Social, environmental, policy and market conditions necessary for development and upscaling	Reliable markets for improved fish breeds products and stable prices
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES. 10/- per fingerling
Estimated returns	Varies according production system (Excel Table to be developed for cost calculations)
Gender issues and concerns in development and dissemination	This technology dissemination process ensured 50% representation of women, youth and vulnerable groups in decision-making processes; and provision of targeted information, education, capacity building to all stakeholders regarding gender awareness as well as on HIV, nutrition and related social aspects.??
Gender issues and concerns in adoption and scaling up	The technology can easily be taken up by women and youth groups
Gender related opportunities	Youth and women can establish sustainable aquaculture business enterprises which act as a source of income and livelihood

VMG issues and concerns in development and dissemination	This is a technology that can be easily carried out by Vulnerable and Marginalized Groups
VMG issues and concerns in adoption and scaling up	The uptake by VMG is still low
VMG related opportunities	The VMG can establish aquaculture enterprises to generate income and livelihood
E: Case studies/profiles of success stories	
Success stories	The best performance of improved seed was conducted in Kilifi and Homa Bay counties with an average fish weight between 400–600g within 7 months. A technical report and poster were developed and
	published for dissemination. Farmers who adopted this technology have had sustained source of income and livelihood
Application guidelines for users	There is need for training manuals and guidelines on Nile tilapia breeding improvement and management techniques
F: Status of TIMP readiness	Ready for upscaling
G: Contacts	
Contacts	Dr Kevin Obiero Kenya Marine and Fisheries Research Institute KMFRI P.O. Box 451-10230, Sagana kmfrinardtc@gmail.com
Lead organization and scientists	The project is being implemented by KMFRI Sagana Centre as the lead institution. The lead scientists are Dr Jonathan Munguti, Dr Kevin Obiero, Ms Mary Opiyo, Ms Domitila Kyule, Cecilia Muthoni, Mr Jacob Abwao, Jane Fonda, Elijah Kembenya and Robert Ondiba
Partner Organizations	• Karatina University • South Eastern Kenya University • Kenya Fisheries Service • National Aquaculture Research and Development Training Centre • County Governments.

Gaps

- Production and maintenance of early generation seed and promote improved seed especially through selective breeding and other genome-based biotechnologies in aquaculture
- Strengthen the local capacity of core stakeholders to achieve the desired outcomes of increasing the productivity of fish in Kenya in a sustainable manner
- Catalyzing growth of competitive seed supply and distribution networks
- Developing and advocating a conducive legal, regulatory and institutional framework for seeds
- Supporting national public-private partnership platforms for seed production

3.1.2 Improved Marine Water Tilapia

Technology name	Improved marine water Nile tilapia
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem to be addressed	Lack of certified quality fish seed. Access to quality inputs in smallscale mariculture is often constrained by the distance to suppliers, a lack of infrastructure or by the cost of inputs. Stunted growth can lead to poor yields and abandonment of fish farming at the coastal counties.
What is it? (TIMP description)	Marine tilapia is an improved breed that has been acclimatized to the marine environment. It tolerates higher salinity levels than the
	normal freshwater tilapias. Status – Ready for upscaling and further genetic improvement programme.
Justification	Demand for tilapia fish and its products is increasing rapidly in Kenya driven by the need for adequate fish protein supply and income generation, increased awareness of the health benefits to consumers as well as changes in population lifestyles and consumer preferences. While wild capture fisheries presently remain the dominant supplier of fish in Kenya, aquaculture is projected to play an important role in sustaining fish supply to meet increasing demand. Therefore, if improved policies and better technologies are adopted, producers can become more involved, with related benefits for environmental sustainability, consumer empowerment and wealth creation.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Input suppliers, authenticated hatcheries, women and youth groups, County Fisheries Departments, Kenya Fisheries Service, Government, Research and Higher Learning Institutions
Approaches used in dissemination	• Training of Trainer (ToT) Manual • Extension publications e.g. posters, leaflets, booklets, information sheets • On-farm and on-station practical demonstrations • Exchange visits to model farms • Training workshops/seminars • Local radio and TV stations • Agricultural shows and exhibitions
Critical/essential factors for successful promotion	• Develop a decentralized breeding PPP model to increase access to improved breed availability • Best Management Aquaculture Practices
Partners/stakeholders for scaling up	• Model fish farms to upscale production of fish in rice fields • National and County Governments to support farmers with matching grants to promote upscaling of rice-fish farming

	• National research institutes, extension agents, education and training institutes, universities, international research institutes and CGIAR to promote technical expertise of producers. • Non-governmental organizations (NGO) and civil society organizations e.g. Farm Africa, World Vision and (Inter)national agricultural/aquaculture networks and associations, cooperatives, development organizations, donors to promote wider adoption of technologies • Aquaculture input suppliers to supply cost effective feeds, seed, equipment and tools • Aquaculture Association of Kenya (AAK) to promote networking among fish farmers and link them with other stakeholders in the aquaculture value chain..
C: Current situation and future scaling up	
Counties where already promoted. (if any)	Kilifi and Kwale counties
Counties where TIMPs will be upscaled	Lamu, Kilifi and Kwale
Challenges in dissemination	Inadequate extension and community outreach programs within the Counties, Inadequate funding
Suggestions for addressing the challenges	• There is need for intensified GAPs training for hatchery operators, grow-out farmers and to the county extension officers for fast and significant impact. • Improve KMFRI'S capacity to produce Broodstock and maintain parental line stock • Allocation of funds for continued research and dissemination to increase uptake of the technology. • Enhanced collaboration with other NARS, Higher Education Institutions for upscaling the technology and continued quality improvement
Lessons learned	Quality affordable feed and water quality management should be enhanced for the improved seed to realize growth and survival performance experienced at the research trials and well operated private farms.
Social, environmental, policy and market conditions necessary	Reliable markets for improved fish breeds products and stable prices, social stability
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES. 10/- per fingerling
Estimated returns	Varies according production system (Excel Table to be developed for cost calculations)
Gender issues and concerns in development and dissemination	This technology dissemination process ensured 50% representation of women, youth and vulnerable groups in decision-making processes; and provision of targeted information, education, capacity building to all stakeholders regarding gender awareness as well as on HIV, nutrition and related social aspects.

Gender issues and concerns in adoption and scaling up	The technology can easily be taken up by women and youth groups
Gender related opportunities	Youth and women can establish sustainable business enterprises and in the distribution chain which act as a source of income and livelihood
VMG issues and concerns in development and dissemination	This is a user-friendly technology that can be easily be adopted by Vulnerable and Marginalized Groups
VMG issues and concerns in adoption and scaling up	Poor outreach, inadequate enabler approaches
VMG related opportunities	The VMG can establish aquaculture enterprises to act as participate in the distribution chain to generate income and livelihood
E: Case studies/profiles of success stories	
Success stories from previous similar projects	The best performance of improved seed was in Kilifi County with an average growth of between 350–500g in 7 months. A technical report was developed and published for dissemination. Farmers adopting the technology have sustainable source of income and livelihood
Application guidelines for users	Need for training manuals and guidelines on Marine Nile tilapia genetic improvement and management, there is need upscaling
F: Status of TIMP readiness	Ready for upscaling
G: Contacts	
Contacts	Assistant Director, Mariculture Kenya Marine and Fisheries Research Institute KMFRI P.O. Box 81651-80100 dimirera@yahoo.com
Lead organization and scientists	The project is being implemented by KMFRI Mombasa Centre as the lead institution. The lead scientists are Dr Jonathan Munguti, Dr. David Mirera, Dr. James Mwaluma, Esther Wairimu, Morine Mukami, Miriam Wainaina.
Partner Organizations	• Pwani University • Kenya Fisheries Service • National Aquaculture Research and Development Training Centre • County Governments.

Gaps

- Production and maintenance of early generation seed and promote improved seed especially through selective breeding and other genome-based biotechnologies in aquaculture
- Catalysing growth of competitive seed supply and distribution networks

3.1.3 Improved Catfish Strain [F3-2017-01]

Technology name	Improved Catfish Strain [F3-2017-01]
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	Lack of quality and fast-growing catfish to supply the desired quantity of fish protein to meet the growing demand for fish protein has necessitated the need for improved strain of catfish. This is due to poor growth performance of available local catfish stocks and poor seed production in hatcheries.
What is it? (TIMP description)	F3-2017-01 is an improved strain of catfish developed through hybridization using three strains of catfish (Indonesian, Dutch and African). On station multiplication of reciprocal breeds of the three reciprocal strains indicates the Indonesian female and Kenyan male (I♀ × K♂) crossbreed performed better for grow out. The crossbreed had a higher survival (78.8%) rate; higher final body weight (327g) and better FCR (1.25). The F3 generation of the hybrid is available for upscaling in target counties
Justification	Catfish is usually a hardy fish which can withstand a wide range of culture conditions. Development of a genetically improved strain of catfish with higher fillet yield has been a priority by researchers
	in Kenya to improve food security in areas that are not predominantly fish eating. Kenya is endowed with different strains of catfish from local to imported strains. If production of the available strains is optimized, food security stability will be ensured.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Fish farmers, authenticated hatcheries, Extension agents, fish distributers, feed manufacturers, HIV heath programmes County Fisheries Departments, Kenya Fisheries Service, Government, Research and Higher Learning Institutions
Approaches to be used in dissemination	• Training of Trainer (ToT) Manual • Extension publications e.g. posters, leaflets, booklets, information sheets • On-farm and on-station practical demonstrations • Exchange visits to model farms • Training workshops/seminars • Local radio and TV stations • Agricultural shows and exhibitions • Farmer field schools
Critical/essential factors for successful promotion	• Well-developed decentralized breeding program to increase access to improved seed availability • Complementary technologies from value addition and reliable markets

Partners/stakeholders for scaling up	• Authenticated hatcheries to scale up the improved breeds to farmers • County fisheries departments to avail improved breeds to farmers for improved livelihoods.
C: Current situation and future scaling up	
Counties where already promoted (if any)	Homa Bay, Kilifi, Kirinyaga, Kisii, Kitui, Laikipia, Machakos, Makueni, Meru, Nakuru, Nyeri, Muranga
Counties where TIMPs will be upscaled	Busia, Kakamega, Siaya, Lamu, Kisumu, Nyandarua (as prioritized by the target counties)
Challenges in dissemination	Inadequate extension and community outreach programs within the Counties
Suggestions for addressing the challenges	• Enhanced collaboration with other NARS, Higher Education Institutions for upscaling the technology and continued research for genetic improvement • Training of farmers and hatchery operators on Best Aquaculture Practices for farmers as well as extension agents at the county level for increased upscale. • Improve KMFRI's and selected farmers' capacity to produce Broodstock and parental stock
Lessons learned in upscaling (if any)	Indonesian strain is recommended for inclusion in the candidates for the selective breeding program. At the same time, measures need to be taken to ensure the purity of the strain. Enhanced growth rate and survival performance at the research trials and well operated private farms.
Social, environmental, policy and market conditions necessary for development and upscaling	• Design technologies that are women friendly (e.g. size, affordability, weight). • Test how technologies fit with user friendly, instead of focusing only on technical solutions. • Provide additional alternative financial support (e.g. credit) to facilitate independent uptake.
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES. 600 per kg
Estimated returns	To be determined based on profitability, break-even points, breakeven yields, operational costs, and initial capital investments
Gender issues and concerns in development and dissemination	Targeting resource-poor and vulnerable households as recipients of smallholder aquaculture innovations and making concerted efforts to impress and involve women in distribution of fingerlings and table fish in selected counties.
Gender issues and concerns in adoption and scaling up	In connection with women-targeted technologies, incorporating training of hatchery operators and monitoring growth performance could add value to learning about overall impacts to allow for scaling up of the technology
Gender related opportunities	Establishment of sustainable business enterprises to act as a source of income
VMG issues and concerns in development, dissemination and upscaling	• Unequal distribution of incomes and other benefits between women and men of different age and social groups who engage in and depend on aquaculture.

	• Women and youths receive little returns due limited land ownership and deep-rooted gender disparities in social, cultural and economic spheres
VMG issues and concerns in adoption and scaling up	The uptake by VMG is moderately high in central Kenya due to changing consumer taste and preferences
VMG related opportunities	The VMG can establish aquaculture enterprises to act as a source revenue
E: Case studies/profiles of success stories	
Success stories from previous similar projects	On station multiplication of reciprocal breeds of catfish strains (Kenyan, Dutch and Indonesian) indicates the Indonesian female and Kenyan male (I♀ × K♂) crossbreed performed better for grow out. The crossbreed had a higher survival (78.8%) rate; higher final body weight (327g) and better FCR (1.25) which are the attributes important to grow-out fish farmers. The hybrid crosses for catfish have been distributed to 5 hatcheries using them as Broodstock e.g. Makindi farms.
Application guidelines for users	Development of fact sheets, training manuals and posters to simplify the breeding protocols and guidelines for Catfish cross breeding and genetic improvement
F: Status of TIMP readiness	Ready for upscaling
G: Contacts	
Contacts	Centre Director, Kenya Marine and Fisheries Research Institute (KMFRI), Sagana Aquaculture Centre kmfrinardtc@gmail.com
Lead organization and scientists	The project is being implemented by KMFRI Sagana Centre as the lead institution. The lead scientists are DrJonathan Munguti, Mary Opiyo, Domitila Kyule, Kevin Obiero, Jacob Abwao, Elijah Kembenya
Partner Organizations	• Kenya Fisheries Service • Karatina University • South Eastern Kenya University • National Aquaculture Research and Development Training Centre • County Governments. • Other NARs and Genetic Improvement Centres in Kenya

Gaps

1. Monitoring of growth and survival of cross breeds which are the attributes important to grow-out fish farmers

3.1.4 Development of YY Super Male Tilapia

Technology name	**YY Tilapia Super Male**
Category (i.e. technology, innovation or management practice)	Technology

A: Description of the technology, innovation or management practice	
Problem to be addressed	Nile tilapia is prolific breeder and can overpopulate a culture facility within a short time. It is therefore necessary to culture mono-sex populations especially males. Manual sexing as a means of producing mono-sex population is labour intensive; and require skill; it is prone to human error and leads to wastage of females.
What is it? (TIMP description)	The end product of normal male tilapia is XY while that of super male is YY. With sex reversal 50% of the phenotypically males are genotypically females with XX chromosomes. Once the YY male is produced it is easy to produce the YY female.
Justification	The YY- technology is one of the most effective methods for production of tilapia mono-sex populations. It is less labour intensive and produces close to 100% all tilapia males.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Fish farmers, Extension agents, fish distributers, feed manufacturers, County Fisheries Departments, Kenya Fisheries Service, Research and Higher Learning Institutions
Approaches to be used in dissemination	Individual hatchery visits, practical demonstrations of the innovation to hatcheries managers, training workshops/seminars, mass media, print media, social media, Agricultural shows and exhibitions, farmer field schools and farmer-to-farmer extension approach.
Critical/essential factors for successful promotion	• Pure parental stock • Suitable water quality • High protein diets for Broodstock
.	• Hatchery farmers • County fisheries departments to offer extension services to farmers.
C: Current situation and future scaling up	
Counties where already promoted (if any)	Net yet in Kenya
Counties where TIMPs will be upscaled	Busia, Siaya, Kakamega, Kisumu and Lamu, Nyandarua
Challenges in dissemination	Inadequate funds, skilled manpower
Suggestions for addressing the challenges	• Enhanced collaboration with other NARS, Higher Education Institutions for upscaling the innovation. Training of hatchery farmers on Best Hatchery Practices as well as extension agents at the county level for increased upscale. • Improve selected farmers' capacity to produce to spawn the brood stock
Lessons learned in upscaling (if any)	Development of pure brood lines. At the same time, measures need to be taken to ensure adequate seed supply. Development of mini hatcheries. Involvement of farmers in trials and involvement of small-scale farmers in the seed production.

Social, environmental, policy and market conditions necessary for development and upscaling	• Design hatcheries that are user- friendly to small farmer (e.g. size, affordability). • Provide YY Broodstock to facilitate independent uptake.
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES. 500 per brood fish
Estimated returns	100% mono-sex population.
Gender issues and concerns in development and dissemination	Targeting resource-poor and vulnerable households as recipients of small holder aquaculture groups and making concerted efforts to involve women in supply of fingerlings to selected counties.
Gender issues and concerns in adoption and scaling up	In connection with women-targeted technologies, incorporating and training of family units in the scaling up of the innovation
Gender related opportunities	Establishment of sustainable business enterprises, groups to supply fingerlings and to make feeds as a source of income.
VMG issues and concerns in development and dissemination	This is an innovation that is user-friendly to Vulnerable and Marginalized Groups
VMG issues and concerns in adoption and scaling up	The uptake by VMG is low at the Coast due to changing economic times
VMG related opportunities	The VMG can establish aquaculture enterprises to act as a source revenue
E: Case studies/profiles of success stories	
Success stories from previous similar projects	On-farm trials have been conducted in Machakos, Kakamega, Nyandarua counties.
Application guidelines for users	Development of fact sheets, training manuals and posters to simplify fingerling production
F: Status of TIMP readiness	Ready for upscaling
G: Contacts	
Contacts	Prof. David Liti, University of Eldoret, P.O. Box 1125, Eldoret
Lead organization and scientists	The project is being implemented by KMFRI Sagana Centre as the lead institution
Partner Organizations	Kenya Marine and Fisheries Research institute

Gaps

1. Need evaluation of sex ratios
2. Optimizing feed formulations for broodstock
3. Design and construction of a hatchery for the YY broodstock

3.2 Indigenous Fish Species

3.2.1 Indigenous Tilapiine species e.g. Victoria tilapia, *Oreochromis variabilis,* Singida tilapia, *Oreochromis esculentus, J*ipe tilapia, *Oreochromis jipe*

Technology name	**Indigenous Fish Species**
Category (i.e. technology, innovation or management	Innovation

practice)	
A: Description of the technology, innovation or management practice	
Problem to be addressed	Lack of diversity of aquaculture farmed species, and conservation of endangered indigenous species (Victoria tilapia- *Oreochromis variabilis,* Singida tilapia, *Oreochromis esculentus*), Jipe tilapia, (*Oreochromis jipe*), Baringo tilapia (*Oreochromis baringoensis*)
What is it? (TIMP description)	The identified indigenous species are native to Lake Victoria, Lake Jipe and Lake Baringo and form the main fishery of the respective lakes, they have high culture potential (Breed in captivity, fast growers and robust)
Justification	Demand for fish and fish products is increasing rapidly in Kenya and is driven by population and income growth, increased awareness of the health benefits of fish, consumption and changes in lifestyles and consumer preferences. While wild capture fisheries presently remain the dominant supplier of fish in Kenya, aquaculture is projected to play an important role in sustaining fish protein supply to meet increasing demand by 2030. Therefore, if improved policies and better technologies are adopted, producers can become more involved, with related benefits for environmental sustainability, consumer empowerment and wealth creation.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Input suppliers, Model authenticated hatcheries, women and youth groups, County Fisheries Departments, Kenya Fisheries Service, Research and Higher Learning Institutions
Approaches to be used in dissemination	• Training of Trainer (ToT) Manual • Extension publications e.g. posters, leaflets, booklets, information sheets • On-farm and on-station practical demonstrations • Exchange visits to model farms • Training workshops/seminars • Local radio and TV stations • Agricultural shows and exhibitions
Critical/essential factors for successful promotion	• Develop a decentralized breeding model to increase access to improved breed stocks • Implementation of Best Management Aquaculture Practices
Partners/stakeholders for scaling up and their roles	• Multipliers / Hatcheries to take up the improved breeds for multiplication and avail to farmers • Engagement of county governments to take up the technology and avail it to farmers for improved livelihoods—food and nutrition security, poverty alleviation and income generation.
C: Current situation and future scaling up	
Counties where already promoted. (if any)	Baringo, Taita Taveta, Kisumu. Homabay, Siaya
Counties where TIMPs will be upscaled	Busia, Kakamega, Siaya, Machakos, (as prioritized by the target counties)

Challenges in dissemination	Inadequate extension and community outreach programs within the Counties
Suggestions for addressing the challenges	• There is need for intensified training for hatchery operators, grow-out farmers and extension officers to the county level for fast and meaningful impact. • Enhance KMFRI, Universities (UoE) and other NARS members, capacity to produce Broodstock and parental stock • Allocation of more funds for continued research and dissemination to increase uptake and adoption of the technology. • Enhanced collaboration with other NARS, Higher Education Institutions for upscaling the technology and continued genetic improvement
Lessons learned in upscaling (if any)	Require mass production of fingerlings, they perform well close to their natural environment, there nutritional requirement need to evaluate for optimal growth under culture conditions
Social, environmental, policy and market conditions necessary for development and upscaling	• Enabling policy frameworks e.g. the Big Four Agenda and Vision 2030 flagship projects • Enhanced nutrition education programmes in Kenya through "Eat More Fish Campaign" to raise the awareness among nonfish-eating tribes on the benefits of fish consumption • Implementation of best management practices and environmental impact assessment/audit • Existence of suitable bio-physical environments in target counties. • Reliable markets for fish products sold from the systems and stable prices.
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES. 10/- per fingerling KES 350/ - Kg of market fish
Estimated returns	Varies according production system (Excel Table to be developed for cost calculations) To be determined during upscaling
Gender issues and concerns in development, dissemination and upscaling	This technology dissemination process will ensure 50% representation of women, youth and vulnerable groups in decisionmaking processes; and provision of targeted information, education,
	capacity building to all stakeholders regarding gender awareness as well as on HIV nutrition and related social aspects.
Gender related opportunities	Youth and women can establish sustainable aquaculture business enterprises which act as a source of income and livelihood
VMG issues and concerns in development, dissemination and upscaling	• Unequal distribution of incomes and other benefits between women and men of different age and social groups who engage in and depend on aquaculture. • VMGs are excluded from access to and benefits from the innovation/ technology.

	• Women and youths receive little returns due limited land ownership and deep-rooted gender disparities in social, cultural and economic spheres
VMG related opportunities	• Increased production will lead to increased consumption of nutritious fish products, hence improved health of VMGs; • Increased awareness on health benefits of fish and changing consumer behavior leading to increased fish demand hence improved incomes for VMGs
E: Case studies/profiles of success stories	
Success stories	The best performance of Indigenous Fish Species was conducted in Taita Taveta, Baringo and Kisumu counties. A technical report and poster were developed and published for dissemination. Farmers who adopted this technology have had sustained source of income and livelihood
Application guidelines for users	There is need for training manuals and guidelines on Indigenous Fish Species for breeding improvement and management techniques
F: Status of TIMP readiness 1. Ready for upscaling 2. Require validation 3. Require further research	Ready for upscaling
G: Contacts	
Contacts	Dr Jonathan Munguti, Sagana Aquaculture Centre Kenya Marine and Fisheries Research Institute KMFRI P.O. Box 451-10230, Sagana kmfrinardtc@gmail.com
Lead organization and scientists	The project is being implemented by KMFRI Sagana Centre as the lead institution. The lead scientists are Dr Jonathan Munguti, Dr Kevin Obiero, Prof. David Liti, Josiah Ani
Partner Organizations	• University of Eldoret • National Aquaculture Research and Development Training Centre • County Governments.

Gaps

1. Mass production of fingerlings
2. Nutritional requirements
3. Evaluation of best culture systems

3.2.2 Indigenous African Carps and Barbs

3.2.2.1 Domestication of Common Barb *Barbus altianalis*

Technology name	**Domestication of *Barbus altinialis (common barbel)***

Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem to be addressed	
What is it? (TIMP description)	Captive breeding and domestication for on-farm production and genetic improvement of the indigenous common barb.
Justification	The common barb is a species of the barb, which can be considered an endangered indigenous fish in the Lake Victoria basin, where it is a delicacy and fetches an attractive price at table size.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Selected farmers in Kisii, Transmara, Homa Bay, Migori, Kisumu and Nyamira, as well as Kisii University and University of Eldoret whose students are also working towards improving the technology.
Approaches to be used in dissemination	Not yet disseminated as the cycle has not yet been closed under aquaculture conditions
Critical/essential factors for successful promotion	1. Mass breeding in multiplication centres for sustainable supply of quality seed for farmer groups in Kenya. 2. Genetic characterization of the different strains is required to identify the genetic vigor that exists in the three strains.
Partners/stakeholders for scaling up	Farmers, County directorates of fisheries, universities
C: Current situation and future scaling up	
Counties where already promoted (if any)	Kisii, Transmara, Homa Bay, Migori, Kisumu and Nyamira counties
Counties where TIMPs will be upscaled	Busia, Siaya, Kakamega, Kisumu
Challenges in dissemination	Lack of documented advisory and extension materials on common barbs
Suggestions for addressing the challenges	To produce and maintain quality Brood stock through selective breeding and other genome-based biotechnologies in aquaculture
Lessons learned	Breeding protocol not yet developed
Social, environmental, policy and market conditions necessary	There is need to close the production cycle for barbs under aquaculture conditions. This will result in the egg hatching and production of the fry in aquaculture. Need to assess the nutritious requirements at all development stages and determining commercialization potential and market conditions of barbs
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Not yet determined
Estimated returns	Not yet determined
Gender issues and concerns in development and dissemination	Use women and youth groups to upscale production and marketing of barbs
Gender issues and concerns in adoption and scaling up	Formation of women and youth groups and strengthening of existing groups that will enable them access SME loans and even larger

	commercial loans/grants to enable them lease land for production as well as access other inputs for production.
Gender related opportunities	Affirmative action that is provided for under the Kenyan constitution for women, youth and other VMGs and also the fact that agriculture in the country is driven by women and youth
VMG issues and concerns in development and dissemination	Awareness creation and capacity building of the women and youth through packaging the findings with the consumer in mind-simplified information and presented in a language that is easily understood.
VMG issues and concerns in adoption and scaling up	Formation of women and youth groups and strengthening existing groups that will enable them access SME loans and even larger commercial loans/grants to enable them lease land for production as well as access other inputs for production.
VMG related opportunities	Uwezo/ youth fund, SMEs, disabled fund and affirmative action for women and youth and other VMGs that will enable them access inputs and market
E: Case studies/profiles of success stories	
Success stories	Barbs have been brought into captivity and been able to adopt well at KMFRI, Kegati research centre
Application guidelines for users	Not yet developed
F: Contacts	
Contacts	KMFRI, Kegati Centre, P. O. Box 3259, Kisii University of Eldoret, P. O. Box 1125, Eldoret Mr Muga, County Directorate of Fisheries, Kisii County
Lead organization and scientists	Dr Paul Orina and Priscilla Boera of KMFRI, Kegati Aquaculture Centre; Prof Okeyo-Owuor and Prof. V. Sudoi of University of Eldoret Mr Muga, County Directorate of Fisheries, Kisii County
Partner organizations	County Directorate of fisheries, Kisii county, Kisii university and UoE, Kisii county

Gaps

- Knowledge gaps in size at maturity, appropriate inducing hormones, growth conditions, egg hatchability and larvae weaning were identified as key challenges associated with *B. altianalis* domestication.
- Understanding the underlying natural ecological dynamics of *B. altianalis* will guide further research in the areas mentioned to ensure advancement in domestication to meet the rising demand for *B. altianalis*.

3.2.2.2 Domestication of Ningu *Labeo victorianus*

Technology name	**Domestication of Ningu *Labeo victorianus***
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	

Problem to be addressed	Diversification of culture species and potential areas for culture.
What is it? (TIMP description)	Propagation of reproduction in *Labeo victorianus* through mass larval production for on-farm growth performance trials under different culture systems.
Justification	In Kenya, there are a few food fish species under aquaculture. However, there exists high demand for *Labeo* in local markets. Its supply from capture fisheries is not adequate to satisfy the consumer demand. Therefore, there is need to evaluate the potential of indigenous species for recruitment to aquaculture and identify methods for optimizing the production of the species for culture.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Fish farmers and hatcheries, fish traders
Approaches to be used in dissemination	• Practical demonstration of breeding process and sharing of results with fish farmers, hatcheries and other stakeholders • Sharing information on KMFRI's website • Summarizing results in progress reports for donors
Critical/essential factors for successful promotion	Willingness of farmers to accept the species, consumer acceptance Timely availability of funds
Partners/stakeholders for scaling up	County Directorates of Fisheries, State Department of Fisheries, farmers, feed manufacturers
C: Current situation and future scaling up	
Counties where already promoted (if any)	Western Kenya including (Kisii, Homa Bay, Migori, Kisumu and Nyamira Counties)
Counties where TIMPs will be upscaled	Busia, Siaya, Kakamega, Kisumu
Challenges in dissemination	Farmers have not been reached yet, information has not been disseminated to stake holders Low adoption rate for a new aquaculture species
Suggestions for addressing the challenges	Holding training workshops and seminars to share "hands on" skills to encourage adoption
Lessons learned for upscaling, if any	Artificial breeding of *L. victorianus* is a good strategy to produce juveniles to boost wild population in Lake Victoria as well as provide source of seeds for culture.
Social, environmental, policy and market conditions necessary	The goal of this program is to maintain and improve the genetic diversity and fitness within populations until their threats are reduced and then reintroduced as self-sustaining populations. *L. victorianus* can be transported at high packing densities thus reducing transport costs to the farmers or researchers transporting the fish because they can transport many fish in one batch with minimal packaging materials.
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Not yet determined
Estimated returns	Not yet determined
Gender issues and concerns in development and dissemination	Use women and youth groups to upscale production and marketing of barbs

Gender issues and concerns in adoption and scaling up	Formation of women and youth groups and strengthening of existing groups that will enable them access SME loans and even larger commercial loans/grants to enable them lease land for production as well as access other inputs for production.
Gender related opportunities	Affirmative action that is provided for under the Kenyan constitution for women, youth and other VMGs and the fact that agriculture in the country is driven by women and youth
VMG issues and concerns in development and dissemination	Awareness creation and capacity building of the women and youth through packaging the findings with the consumer in mind- simplified and presented in a language that is easily understood.
VMG issues and concerns in adoption and scaling up	Formation of women and youth groups and strengthening existing groups that will enable them access SME loans and even larger commercial loans/grants to enable them lease land for production as well as access other inputs for production.
VMG related opportunities	Uwezo/Youth Fund, SMEs, disabled fund and affirmative action for women and youth and other VMGs that will enable them access inputs and market
E: Case studies/profiles of success stories	
Success stories	Barbs has been brought into captivity recently and has been able to adopt well at KMFRI, Kegati research Centre
Application guidelines for users	Not yet developed
F: Status of TIMP readiness	
G: Contacts	
Contacts	Mr Elijah Kembenya KMFRI, Sangoro Centre, P. O. Box 136 – 40111, Pap Onditi kembenyaelijah@gmail.com | +254
Lead organization and scientists	KMFRI Sangoro Centre - Dr. Kevin Obiero, Dr Jonathan Munguti, Dr Paul Orina, Priscilla Boera of KMFRI, Kegati Aquaculture Centre Mr. Muga, County Directorate of Fisheries, Kisii County
Partner organizations	County Government, NARS and Academic Institutions,

Gaps

- Knowledge gaps in size at maturity, appropriate inducing hormones, growth conditions, egg hatchability and larvae weaning were identified as key challenges associated with *Labeo victorianus* domestication**.**

3.3 Coastal aquaculture species

3.3.1 Milkfish *Chanos chanos*

Technology name	**KMFRI – Milkfish farming**
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	

Problem to be addressed	Seasonality of seed and reliance on the wild has been a major hindrance to milkfish culture. Technology adoption, access to quality inputs in milkfish culture is often constrained by lack of resources as most of the farmers come from poor coastal communities, lack of infrastructure and market competition from the fisher folks has also been a hindrance to the sector
What is it? (TIMP description)	Milkfish is endemic to the marine environment with growth traits that has enabled farmers try it in ponds located in the intertidal areas. Status – Ready for upscaling with provision of seed through hatchery establishment.
Justification	Demand for fish and fish products is increasing rapidly in Kenya driven by population and income growth, increased awareness of the health benefits of fish consumption and changes in lifestyles and consumer preferences. While wild capture fisheries presently remain the dominant supplier of fish in Kenya, aquaculture is projected to play an important role in sustaining fish supply to meet increasing demand to 2030. Therefore, if improved policies and better technologies are adopted, producers can become more involved, with related benefits for environmental sustainability, consumer empowerment and wealth creation.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Input suppliers, Model authenticated hatcheries, women and youth groups, County Fisheries Departments, Kenya Fisheries Service, Government, Research and Higher Learning Institutions
Approaches to be used in dissemination	• Training of Trainer (ToT) Manual • Extension publications e.g. posters, leaflets, booklets, information sheets • On-farm and on-station practical demonstrations • Exchange visits to model farms • Training workshops/seminars • Local radio and TV stations • Agricultural shows and exhibitions
Critical/essential factors for successful promotion	• Develop a decentralized breeding PPP model to increase access to improved breed availability • Good Aquaculture Practices
Partners/stakeholders for scaling up	• Multipliers / Hatcheries to take up the improved breeds for multiplication and avail to farmers • Engagement of county governments to take up the technology and avail it to farmers for improved livelihoods—food and nutrition security, poverty alleviation and income generation.
C: Current situation and future scaling up	
Counties where already promoted (if any)	Kilifi and Kwale counties
Counties where TIMPs will be upscaled	Lamu, Kilifi and Kwale

Challenges in dissemination	Inadequate extension and community outreach programs within the Counties Lack of funding
Recommendations for addressing the challenges	• There is need for intensified GAPs training for hatchery operators, grow-out farmers and extension to the county level for fast and meaningful impact. • Improve KMFRI capacity to produce Broodstock and parental stock • Allocation of more funds for continued research and dissemination to increase uptake of the technology. • Enhanced collaboration with other NARS, Higher Education Institutions for upscaling the technology and continued genetic improvement
Lessons learned	Quality affordable feed and water quality management should be enhanced for the improved seed to realize growth and survival performance experienced at the research trials.
Social, environmental, policy and market conditions necessary	Reliable markets for improved fish breeds products and stable prices
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES. 10/- per fingerling
Estimated returns	Varies according production system (Excel Table to be developed for cost calculations)
Gender issues and concerns in development and dissemination	This technology dissemination process ensured 50% representation of women, youth and vulnerable groups in decision-making processes; and provision of targeted information, education, capacity building to all stakeholders regarding gender awareness as well as on HIV, nutrition and related social aspects.
Gender issues and concerns in adoption and scaling up	The technology easily be taken up by women and youth groups
Gender related opportunities	Youth and women can establish sustainable business enterprises which act as a source of income and livelihood (Feed cottage industries, sale of fish both fresh and value added, sale of fingerlings).
VMG issues and concerns in development and dissemination	This is a technology that can be easily carried out by Vulnerable and Marginalized Groups
VMG issues and concerns in adoption and scaling up	The uptake by VMG is still low
VMG related opportunities	The VMG can establish aquaculture enterprises to act as a source of income and livelihood
E: Case studies/profiles of success stories	
Success stories	The best performance of improved seed was in Kwale county (Baraka Makongeni group) with an average growth of between 300 –600g in 8 months. A technical report developed and published for dissemination. Farmers who adopted this technology have had sustained source of income and livelihood

Application guidelines for users	Need for training manuals and guidelines on milkfish culture
F: Contacts	
Contacts	Prof. David Liti University of Eldoret P.O.Box 1125 Eldoret davidmbevaliti@gmail.com Dr David Mirera Kenya Marine and Fisheries Research Institute KMFRI P.O. Box 81651-80100 dimirera@yahoo.com
Lead organization and scientists	The project is being implemented by KMFRI Mombasa Centre as the lead institution. The lead scientists are Dr Jonathan Munguti, Dr. David Mirera, Dr. James Mwaluma, Esther Wairimu, Morine Mukami, Miriam Wainaina, Agwata Ototo, Jared Nyabeta
Partner Organizations	• Pwani University • Kenya Fisheries Service • National Aquaculture Research and Development Training Centre • County Governments.

3.3.2 Red snapper, *Lutjanus argentinamaculus*

Technology name	**Red snapper cage culture**
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem to be addressed	Most of fisheries stocks are considered overfished. Therefore, there is need to enhance fisheries management efforts to reduce the pressure on the wild stocks.
What is it? (TIMP description)	Mangove red snapper (*Lutjanus argentinamaculus*) is one of the highly valued marine species with great potential for aquaculture. Preferred site for *L. argentinamaculus* would have a mangrove buffer zonecovering 20-100m. In ponds stocking density is about 5,000/ha. Dietary protein is about 48-50%. Feed constitute 67-70%. Fingerlings 23-25%. Feed conversion ratio 2.5. Return to investment 43%, payment period 1.8 yrs.
Justification	*L. argentinamaculus* is one of the popular species for coastal aquaculture. It has several advantages for aquaculture enterprises. It is a fast grower and has a feed conversion ratio of 2.5. Return to investment of 43% and payment period of 1.8 yrs. However, despite the high potential, it has not yet been introduced to Kenyan marine waters.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Fish farmers, Extension agents, fish distributers, feed manufacturers, HIV heath programmes, County Fisheries

	Departments, Kenya Fisheries Service, Government, Research and Higher Learning Institutions
Approaches to be used in dissemination	Individual farm visits, farmer field days, practical demonstrations of the innovation, training workshops/seminars, mass media, print
	media, social media, Agricultural shows and exhibitions, farmer field schools and farmer-to-farmer extension approach.
Critical/essential factors for successful promotion	• Suitable site selection and seed availability • Suitable dietary formulations
Partners/stakeholders for scaling up	• Farmers • County fisheries departments to offer extension services to farmers.
C: Current situation and future scaling up	
Counties where already promoted (if any)	South coast of Kenya
Counties where TIMPs will be upscaled	Kwale, Kilifi and Lamu
Challenges in dissemination	Inadequate funds
Suggestions for addressing the challenges	• Enhanced collaboration with other NARS, Higher Education Institutions for upscaling the innovation. Training of farmers on Best Aquaculture Practices for farmers as well as extension agents at the county level for increased upscale. • Improve selected farmers' capacity to produce to cage farming.
Lessons learned in upscaling (if any)	Introduction of robust cages to withstand the strong waves. At the same time, measures need to be taken to ensure adequate seed supply Enhanced growth rate and survival performance at the research trials and involvement of small-scale farmers.
Social, environmental, policy and market conditions necessary for development and upscaling	• Design technologies that are user- friendly to small farmer (e.g. size, affordability). • Provide additional alternative financial support (e.g. credit) to facilitate independent uptake.
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES. 600 per kg of fish Feed constitute 67-70%. Fingerlings 23-25%. Feed conversion ratio 2.5.
Estimated returns	Return to investment 43%, payment period 1.8 yrs.
Gender issues and concerns in development and dissemination	Targeting resource-poor and vulnerable households as recipients of small holder aquaculture groups and making concerted efforts to impress and involve women in supply of fingerlings in selected counties.
Gender issues and concerns in adoption and scaling up	In connection with women-targeted technologies, incorporating and training of family units in the scaling up of the innovation
Gender related opportunities	Establishment of sustainable business enterprises, groups to supply fingerlings and to make feeds as a source of income.
VMG issues and concerns in development and dissemination	This is an innovation that is user-friendly to Vulnerable and Marginalized Groups

VMG issues and concerns in adoption and scaling up	The uptake by VMG is low at the Coast due to changing economic times
VMG related opportunities	The VMG can establish aquaculture enterprises to act as a source revenue
E: Case studies/profiles of success stories	
Success stories from previous similar projects	On-farm trials have been conducted in Kwale count where red snapper demonstrated better growth than milkfish.
Application guidelines for users	Development of fact sheets, training manuals and posters to simplify the cage costs and Best management practices
F: Status of TIMP readiness	Ready for upscaling
G: Contacts	
Contacts	Prof. David Liti University of Eldoret P.O. Box 1125, Eldoret
Lead organization and scientists	The project is being implemented by KMFRI Sagana Centre as the lead institution. Prof. David Liti *davidmbevaliti@gmail.com*
Partner Organizations	• Kenya Marine and Fisheries Research institute • Kwetu Training Centre

Gaps
1. Need evaluation of stocking densities
2. Optimizing feed formulations for the species
3. Design and construction of a hatchery for the species to ensure sustainable supply of seeds

3.3.3 Mud crab Cage culture

Technology name	**Mud Crab Cage culture**
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem to be addressed	To support mud crab farming, several research studies have been undertaken and documented by KMFRI Mombasa compared to any other marine species in Kenya. Initially crab farming was initiated as drive in (bottom cages) cages using sticks. Later, floating cages made of bamboos were recommended for adoption with preferable stocking of males. The culture systems thus adopted by the groups are floating cages made of bamboo structures. However, these cages have been observed to have high maintenance costs due to the frequent repairs involved. Currently KMFRI has spearheaded the research and trails of plastic cages which have currently been adopted for use in by Dabaso Creek Conservation group (Watamu) and Comensum Group (Mtwapa). Apart from the lower maintenance costs, plastic cages have lower cost per cage as compared to bamboo

	(factoring in labour) and shorter fabrication time. Environmentally cutting of trees (bamboos and sticks) is reduced. These can be replicated to other areas providing income and livelihood opportunities to coastal communities.
What is it? (TIMP description)	Small_ cage culture systems (3000 t/yr production) for set of 10 cages.
Justification	Crab fattening with cages has many advantages over other methods of fish culture, including: high value marine species and high production per unit volume of cage; relatively low investment per unit of production; the anticipated high profitability levels; high durability, the use of existing water bodies thus reducing the pressure on land; the requirements of relatively low capital outlay; the ease of movement and relocation; the reduced effect of drought on production in relation to the availability of water; and the flexibility of management.
Region promoted	Lamu, Kilifi, Mombasa, Kwale counties
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Community groups, Crab farmers, County Governments,
Approaches used in dissemination	Model cage farmers, practical demonstration (peer learning),
Most effective approach	Practical demonstration of cage systems at county levels
Critical/essential factors for successful promotion	Environmental impact assessment, site suitability maps,
Partners/stakeholders for scaling up	• Community groups (registered CBO's) • County Governments, • Private Mariculture farmers (individual) • Model fish farms, • Kenya Fisheries Service (KeFS) • Aquaculture Association of Kenya (AAK)
C: Current situation and future scaling up	
Counties where already promoted (if any)	40 model crab cages system successfully established at Mtwapa Majaoni and a further 30 already in use at Dabaso, Watamu ready for upscaling
Counties where TIMPs will be upscaled	Kilifi, Lamu, Kwale
Challenges in dissemination	Limited awareness of cage existence, lack of knowledge in fabrication,
Suggestions for addressing the challenges	• Awareness campaigns (set up of demonstration centers, brochures etc) • Conduct training campaigns (Hands on training) • Encourage aquaculture equipment producers in Kenya to invest in producing the equipment • Invest in crab cages
Lessons learned	Lower fabrication costs, lower maintenance costs, and high versatility within the mangroves ensure high sustainability and

	production. Domesticating crab cages to the use of locally fabricated equipment and avoidance of cutting bamboos previously used.
Social, environmental, policy and market conditions necessary	Organized registered groups, use of trash fish (fish offals as feed for crabs), farming within the mangroves (encouraging mangrove reforestation) Reliable markets for crab meat and stable prices
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	
Estimated returns	Estimated returns depend on the magnitude of the cage established.
Gender issues and concerns in development and dissemination	Gender equity in provision of targeted information, practical demonstration, capacity building to all stakeholders on the application of technology
Gender issues and concerns in adoption and scaling-up	Crab cage farming is easy to set up adopt. Therefore, women and youth groups should be supported to adopt the technology
Gender related opportunities	Youth and women groups can be supported to establish crab cage culture operations along the riparian counties
VMG issues and concerns in development and dissemination	The Vulnerable and Marginalized Groups requires financial support to set up cage operations.
VMG issues and concerns in adoption and scaling up	The uptake by VMG is limited
VMG related opportunities	The VMG can partner with county governments to set up cage culture operation to act as a source of income and improved livelihood
E: Case studies/profiles of success stories	
Success stories	Crab fattening in cages is a new emerging coastal type of mariculture which has been practiced successfully in the last 5 years. Crabs are captured from the wild and fattened in cages. Feeds include fish offal purchased from fish processors in the village, discarded food and remains from the restaurant kitchen). Production volumes are currently around 500 crabs/annum (depending on number of cages). The crabs are prepared and sold at the restaurant on-site (KES1200/piece) as well as to local hotels and restaurants (KES 600/kg). Crab farming has is now being embraced togther with mangrove conservation into ecotourism facilities e.g at Dabaso Watamu (see www.crabshack.com) as an important income and employment. Currently, there are 70 crab cages (30 Dabaso group) and 40 (Comensum group) in Kilifi county with a potential to produce 3,000 tonnes of crabs per year.
Application guidelines for users	Development of crab cage training manuals, cage guidelines, suitability maps, fact sheets, booklets and posters to simplify cage fabrication and operations
F. Status of TIMP readiness	Ready for upscaling
F: Contacts	
Contacts	Dr James Mwaluma/Dr David Mirera Kenya Marine and Fisheries Research Institute KMFRI P.O. Box 81651, Mombasa jamesmwaluma@gmail.com

Lead organization and scientists	Kenya Marine & Fisheries Research Institute (KMFRI) Mombasa Centre as the lead institution is implementing the project. The lead scientists are Dr. Jonathan Munguti, Dr James Mwaluma, Dr David Mirera, Miriam Wainaina, Esther Wairimu.
Partner organizations	• Community based Organisations (CBO's) • County Governments, cottage feed producers, model farmers • Aquaculture Association of Kenya (AAK)
	KeFs State Department of Fisheries and Blue economy Kenya Fisheries Service

Gaps

1. Further genetic improvements
2. Environmental conservation of culture areas

3.3.4 Prawn (*Penaeus monodon*) farming

Technology name	**Pond culture of prawns**
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem to be addressed	Low scale production systems, Lack of quality certified prawn seeds. Access to quality seeds in small-scale mariculture is often constrained by the lack of suppliers due to lack of infrastructure (marine hatchery)
What is it? (TIMP description)	In Kenya, the prawn species cultured are *Penaeus monodon* and *Fenneropenaeus indicus* and seed was obtained from the wild. It is currently cultured in ponds but at subsistence levels. It is a highquality species with ready market. Status – Ready for upscaling and further genetic improvement programme.
Justification	Prawns are high value species with a potential of earning high income for local communities. Basic infrastructures (ponds) are already available in Kwale (Makongeni) and Kilifi (Kibokoni). Demand for prawns is high and therefore ready markets available. If better production systems and technologies are utilized, the farming has a potential for youth/women empowerment and wealth creation. Additionally, community groups who have had previous trials are involved in environmental conservation through planting of mangroves around the ponds.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Community Based Organization, Individual farmers, Input suppliers (Mtoni Farm), Model authenticated hatcheries, women and youth

	groups, County Fisheries Departments, Kenya Fisheries Service, Government, Research and Higher Learning Institutions
Approaches used in dissemination	Individual farm visits, practical demonstrations of farming technology, training workshops/seminars, mass media, print media, social media, Agricultural shows and exhibitions, farmer field schools and farmer-to-farmer extension approach.
Most effective approach	Establishment of Demo/model farms especially in Makongeni (Kwale) and Kibokoni (Kilifi) and, farmer to farmer trainings and practical demonstrations.
Critical/essential factors for successful promotion	● Develop demonstration farms in Kwale and Kilifi. This will serve as models to increase awareness and training ● Good Aquaculture and Business Practices
Partners/stakeholders for scaling up	● Multipliers / Hatcheries (Mtoni prawn hatchery Kilifi) to take up the improved breeds for multiplication and avail to farmers ● Engagement of CBO's and County governments to take up the technology and avail it to farmers for improved livelihoods—food and nutrition security, poverty alleviation and income generation.
C: Current situation and future scaling up	
Counties where already promoted. (if any)	Kwale and Kilifi
Counties where TIMPs will be upscaled	Lamu, Kilifi, Kwale
Challenges in dissemination	Inadequate extension and community outreach programs within the Counties. Inadequate extension staff in the counties.
Suggestions for addressing the challenges	● There is need for intensified GAPs training for hatchery operators, grow-out farmers and extension to the county level for fast and meaningful impact. ● Allocation of more funds for continued research and dissemination to increase uptake of the technology. ● Enhanced collaboration with other Institutions and stakeholders for upscaling the technology
Lessons learned	For many years, less focus has been given to development of smallscale prawn farming although through Kenya Coastal Development Project (KCDP) interventions (2012–2017) this has been enhanced. 5–8 production ponds (40x30 m) have been constructed in Kwale and Kilifi can be used for commercial production.
Social, environmental, policy and market conditions necessary	Reliable markets are present for this high value fish and stable prices. CBO's involved with this activity will combine mangrove rehabilitation and reforestation activities
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES. 10/- per fingerling for stocking, feeds 5000 KES/month

Estimated returns	Varies according production system (Excel Table to be developed for cost calculations)
Gender issues and concerns in development and dissemination	This technology dissemination process ensured 50% representation of women, youth and vulnerable groups in decision-making processes; and provision of targeted information, education, capacity building to all stakeholders regarding gender awareness as well as on HIV, nutrition and related social aspects.
Gender issues and concerns in adoption and scaling up	The technology easily be taken up by women and youth groups
Gender related opportunities	Youth and women can establish sustainable business enterprises which act as a source of income and livelihood
VMG issues and concerns in development and dissemination	This is a technology that can be easily carried out by Vulnerable and Marginalized Groups
VMG issues and concerns in adoption and scaling up	The uptake by VMG is still low
VMG related opportunities	The VMG can establish 56agriculture enterprises to act as a source of income and livelihood
E: Case studies/profiles of success stories	
Success stories	Trials have been carried out in Kilifi and Kwale counties with culture of two species *Penaeus monodon* and *Fenneropenaeus indicus*. Harvest regimes of between 100-200kr/yr have been achieved but this can be improved with availability of seeds all year round.
Application guidelines for users	Need for training manuals and guidelines on prawn production improvement and management, business models, record keeping
F. Status of TIMP readiness	Ready for upscaling
g: Contacts	
Contacts	Dr David Mirera /Dr James Mwaluma Kenya Marine and Fisheries Research Institute KMFRI P.O. Box 81651-80100 dimirera@yahoo.com Brenda Muli, Kwetu training centre
Lead organization and scientists	The project is being implemented by KMFRI Mombasa Centre as the lead institution. The lead scientists are Dr Jonathan Munguti, Dr. David Mirera, Dr. James Mwaluma, Esther Wairimu, Morine Mukami and Miriam Wainaina
Partner Organizations	● Pwani University ● Kenya Fisheries Service ● National Aquaculture Research and Development Training Centre ● County Governments. ● Mtoni prawn Hatchery ● Kwetu training centre marine section

Gaps

1. Freshwater prawns remain undomesticated, need for further genetic work for domestication.

3.3.5 Seaweed farming

Technology name	**Improved culture technique for *Kappaphycus alvarezii* "cottonii"**
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem to be addressed	Despite its higher gate price than *Eucheuma denticulatum*, the culture of seaweed, *Kappaphycus alvarezii* "cottonii has perennially revealed low biomass production in Kenya. The low production has been partly associated with increasing seawater temperature and lack of appropriate and accessible culture technique that can be adopted by farmers especially women who have poor swimming ability in deeper areas where the culture of this species has been recommended.
What is it? (TIMP description)	Modified off-bottom (MB) culture technique has been innovated as a hybrid of Fixed off-bottom (FB) and Floating raft culture techniques of seaweed farming with ease of accessibility by farmers with limited swimming abilities in deeper water environments Status – Ready for upscaling and conducting economic analysis of its application
Justification	The kappa carrageenan is a seaweed gel predominantly extracted from *Kappaphycus alvarezii* (Doty) Doty ex Silva while iotacarrageenan from *Eucheuma denticulatum* (Collins & Hervey). Due to the diverse use of carrageenans in the processing industries, their global demand is expected to continuously grow at an annual rate of 4–6% (McHugh, 2003). Besides contributing to the global volume demand of these seaweeds, commercial cultivation technology in Kenya has been adopted in the southern coast since 2013. To date the technology has been widely accepted as a potential source of alternative livelihood for the coastal communities in Kwale County.Therefore, if farming technologies are improved to increase production of both species and adopted, there could be enhanced motivation to farmers and wealth creation thus sustaining this technology as well as saving *Kappaphycus alvarezii* from imminent extinction in Kenyan waters.
Region promoted	Kwale
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Seaweed farmers, Seaweed investors, Beach management units (BMU), Youth groups, County Fisheries Departments, Government, Research and Higher Learning Institutions

Approaches used in dissemination	Practical demonstrations of technology in the field, training workshops/seminars
Most effective approach	Model farm and farmer to farmer trainings and practical demonstrations
Critical/essential factors for successful promotion	• Establishment of model farms at suitable seaweed cultivation sites along the coast belt to increase capacity building in this technology • Adherence to mariculture Practices and Hygiene
Partners/stakeholders for scaling up	• Seaweed investors/ regional buyers and international traders • Engagement of county governments to take up the technology and avail it to farmers for improved livelihoods—food and nutrition security, poverty alleviation and income generation.
C: Current situation and future scaling up	
Current extent of reach	Moderate (medium)
Challenges in dissemination	Limited funds for researchers to set up model farms and enhance sensitization to the consumers of the technology Inadequate extension and community outreach programs within the Counties
Recommendations for addressing the challenges	• There is need for initiating strong collaboration programe with seaweed mariculture stake holders for upscaling commercial production of *Kappaphycus*which include developing a data base for suitable sites for its cultivation in Kenya through experts from KMFRI, • County Governments of Kwale, Kilifi and Lamu to consider providing initial farming assets to interested farmers. • State department of Fisheries to provide extension services and curb resource user conflicts • KMFRI to partner with NGOs to initiate value addition of cultivated seaweeds. • The product development and enterprise wing of KMFRI to embark on aggressive mission to promote Kenyan seaweed in the international market • Improve KMFRI expertise capacity in seaweed production • Allocation of more funds for continued research and dissemination to increase uptake of the technology. • Enhanced collaboration with Higher Education Institutions for continued genetic improvement of seaweed species
Lessons learned	For increased yields to be realized from improved culture technology, there is need for investors and donors to provide initial assets to farmers and invest in continuous seaweed research activities due to its vulnerability to changes in seawater quality parameters. These factors are critical in assuring steady biomass production especially for the developing countries in the tropics.
Social, environmental, policy and market conditions necessary	Reliable markets for seaweed raw materials and value-added products and stable prices
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	

Basic costs	KES. 30/- per Kg dwt seaweed
Estimated returns	Varies according production system (Excel Table to be developed for cost calculations)
Gender issues and concerns in development and dissemination	This technology dissemination process ensured 50% representation of women, youth and vulnerable groups in decision-making processes; and provision of targeted information, education, capacity building to all stakeholders regarding gender awareness as well as on HIV, nutrition and related social aspects.
Gender issues and concerns in adoption and scaling up	The technology easily be taken up by women and youth groups
Gender related opportunities	Youth and women can establish sustainable business enterprises which act as a source of income and livelihood
VMG issues and concerns in development and dissemination	This is a technology that can be easily carried out by Vulnerable and Marginalized Groups
VMG issues and concerns in adoption and scaling up	The uptake by VMG is still low
VMG related opportunities	The VMG can establish mariculture enterprises to act as a source of income and livelihood
E: Case studies/profiles of success stories	
Success stories	The best performance of improved seaweed culture technique was in Kwale count with an average growth of between 0.3 – 5.7 % d^{-1} for *K. alvarezii* at Mkwiro. A technical report was developed and published for dissemination and a publication in the journal of Western Indian Ocean is in the public domain. Community farmers at Mkwiro who participated in testing this technology are enthusiastically waiting for an investor who could provide them with initial capital to start the farming of this valuable species.
Application guidelines for users	Need for training manuals and guidelines on different culture techniques with potential to improve seaweed production and management
F: Contacts	
Contacts	Dr. David Mirera Kenya Marine and Fisheries Research Institute KMFRI P.O. Box 81651-80100 dimirera@yahoo.com
Lead organization and scientists	The project is being implemented by KMFRI Mombasa Centre as the lead institution. The lead scientists are Dr Jonathan Munguti, Alex Kimathi, Jackline Olando
Partner Organizations	• Plan International • Kenya Fisheries Service • National Aquaculture Research and Development Training Centre • County Governments.

3.4 Potential species under culture trials e.g. Lung fish, *Protopterus aethiopicus*

Technology name	**Potential species under culture trials e.g. Lung fish, *Protopterus aethiopicus***
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem to be addressed	Lack of adequate high-quality lungfish seed. The production of adequate high-quality seeds is largely constrained by the inability to identify sexes physically which is a prerequisite for artificial propagation. Low survival rates experienced is mainly due to cannibalism, poor water quality and hatchability challenges.
What is it? (TIMP description)	African lungfish of the genus *Protopterus* is well-known as obligatory air breather and for its ability to survive temporary, and sometimes extended, desiccation of their habitat. It portrays the ability to survive and do very well even in poor water quality environments. It is because of the quality of its meat in terms of
	flesh to bone ratio and the unique strong taste that many fishermen and consumers prefer it. It has a faster growth as compared to many fish species hence need to domesticate it.
Justification	The demand for fish and fish by products is increasing rapidly globally and is attributed mainly to the ever-increasing human population. As much as there is a lot of progress in the breeding of Nile tilapia and African catfish scanty information exists about propagation of Lungfishes. Any progress related to lungfish propagation and other breeding protocols will greatly assist hatcheries dealing with this specific species
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Input suppliers, Model authenticated hatcheries, women and youth groups, County Fisheries Departments, Kenya Fisheries Service, Research and Higher Learning Institutions
Approaches to be used in dissemination	Individual farm visits, practical demonstrations of technology, training workshops/seminars, mass media, print media, social media, Agricultural shows and exhibitions, farmer field schools and farmer-to-farmer extension approach.
Critical/essential factors for successful promotion	• Develop a decentralized breeding PPP model to increase access to improved breed stocks • Best Management Aquaculture Practices
Partners/stakeholders for scaling up and their roles	• Multipliers / Hatcheries to take up the improved breeds for multiplication and avail to farmers • Engagement of county governments to take up the technology and avail it to farmers for improved livelihoods—food and nutrition security, poverty alleviation and income generation.
C: Current situation and future scaling up	
Counties where already	None so far

promoted. (if any)	
Counties where TIMPs will be upscaled	Busia, Kakamega, Siaya, Kisumu, Kisii (as prioritized by the target counties)
Challenges in dissemination	Inadequate extension and community outreach programs within the Counties
Suggestions for addressing the challenges	• There is need for intensified GAPs training for hatchery operators, grow-out farmers and extension officers to the county level for fast and meaningful impact. • Improve KMFRI capacity to produce Broodstock and parental stock • Allocation of more funds for continued research and dissemination to increase uptake and adoption of the technology. • Enhanced collaboration with other NARS, Higher Education Institutions for upscaling the technology and continued genetic improvement
Lessons learned in upscaling (if any)	• Lungfish accept commercial feeds gradually • Increase in body weight is directly proportional to the increase of protein level in the feeds • Feed whose CP ranges between 35-50% giving an FCR ranging from 1.61 to 2.07
Social, environmental, policy and market conditions necessary for development and upscaling	Reliable markets for improved fish breeds products and stable prices
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES. 10/- per fingerling
Estimated returns	Varies according production system (Excel Table to be developed for cost calculations)
Gender issues and concerns in development and dissemination	This technology dissemination process ensured 50% representation of women, youth and vulnerable groups in decision-making processes; and provision of targeted information, education, capacity building to all stakeholders regarding gender awareness as well as on HIV, nutrition and related social aspects.
Gender issues and concerns in adoption and scaling up	The technology can easily be taken up by women and youth groups
Gender related opportunities	Youth and women can establish sustainable aquaculture business enterprises which act as a source of income and livelihood
VMG issues and concerns in development and dissemination	This is a technology that can be easily carried out by Vulnerable and Marginalized Groups
VMG issues and concerns in adoption and scaling up	The uptake by VMG is still low
VMG related opportunities	The VMG can establish aquaculture enterprises to generate income and livelihood
E: Case studies/profiles of success stories	

Success stories	The best performance of improved seed was conducted within the Lake Victoria basin at Kajjansi Uganda. Fingerlings were raised up to table size.
Application guidelines for users	There is need for training manuals and guidelines on Lungfish breeding improvement and management techniques
F: Status of TIMP readiness	Require further research
G: Contacts	
Contacts	Dr Kevin Obiero Kenya Marine and Fisheries Research Institute KMFRI P.O. Box 451-10230, Sagana kmfrinardtc@gmail.com
Lead organization and scientists	The project is being implemented by KMFRI Sagana Centre as the lead institution. The lead scientists are Dr Jonathan Munguti, Dr Kevin Obiero, Ms Mary Opiyo, Ms Leah Kerengo, Cecilia Muthoni, Mr Jacob Abwao, Jane Fonda, Elijah Kembenya and Robert Ondiba
Partner Organizations	• Karatina University • University of Eldoret • South Eastern Kenya University • Kenya Fisheries Service • National Aquaculture Research and Development Training Centre • County Governments.

Gaps

1. Low survival rates of fingerlings is mainly due to cannibalism, poor water quality and hatchability
2. Sex determination of males and females

3.5 Fish breeding techniques

3.5.1 Hormonal Sex Reversal for Monosex tilapia fingerlings

Technology name	**Hormonal Sex Reversal**
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	The prolific breeding of tilapias leads to stunted growth and poor yields and desperation in fish farming across the country. Tilapia display sexual growth dimorphism with male tilapia growing faster than females.
What is it? (TIMP description)	All-male population of Nile tilapia can be produced through hormonal sex reversal through direct application of hormones using 17-α-methyltestosterone (17-α-MT) one of the most common methods for commercial production of Nile tilapia male populations. The monosex fingerlings are initially fed with 17-αmethyl testosterone treated diet (60 mg kg^{-1} feed) first at the rate of 10% body weight and then gradually reduced to 5% body weight

	per day for 28 days to produce Sex-Reversed Male Tilapia (SRT). Fish that have been sex reversed using hormones act and look like males (phenotypic males), but they still carry the female genetic makeup: XX (genotypically females). Hormone feed is prepared using the impregnated food technique. Alcohol is used to dissolve the hormone at 60 mg of hormone into 500ml of alcohol per kg of feed. The hormone feed is then fed 16 hours daily for 21-28 days in the hatchery. 1kg of feed is fed to 2000-3000 frys. Status – Ready for upscaling
Justification	When Nile tilapia fry are hatched, they are genetically determined as male or female. However, at the time of hatching, they are physically indeterminate, i.e. they do not possess gonads. It is, therefore, possible, in the early stages of fry development, to influence the development of the gonads by hormonal intervention. The sex-reversal technology produces a uniform size of fastergrowing males and prevented problems of unwanted reproduction, overcrowding, and harvest of stunted fish
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Input suppliers, Model authenticated hatcheries, women and youth groups, County Fisheries Departments, Kenya Fisheries Service, Government, Research and Higher Learning Institutions
Approaches to be used in dissemination	Individual farm visits, practical demonstrations of technology, training workshops/seminars, mass media, print media, social media, Agricultural shows and exhibitions, farmer field schools and farmer-to-farmer extension approach.
Critical/essential factors for successful promotion	Factors which are important to ensure good and efficient sex reversal includes: • Age of fry (<17–24 days) • Correct hormone dose (40–60 mg) • High palatability of feed (25–45% protein) • High frequency of feeding (3–6x per day) • Lack of disease • Optimum temperature (28–32 ^{o}C) • Even size to prevent cannibalism • Control level of natural food • Protect storage of the hormone and hormone • treated feed (4 ^{o}C) • Optimum fry density (1,000/m^2 or 12 fry/liter)
Partners/stakeholders for scaling up	• Multipliers / Hatcheries to take up the improved breeds for multiplication and avail to farmers • Engagement of county governments to take up the technology and avail it to farmers for improved livelihoods—food and nutrition security, poverty alleviation and income generation.
C: Current situation and future scaling up	
Counties where already promoted. (if any)	Countrywide

Counties where TIMPs will be upscaled	Kakamega, Busia, Siaya, Lamu,
Challenges in dissemination	Inadequate extension and community outreach programs within the Counties
Recommendations for addressing the challenges	• There is need for intensified GAPs training for hatchery operators, grow-out farmers and extension to the county level for fast and meaningful impact. • Improve KMFRI capacity to produce Broodstock and parental stock • Allocation of more funds for continued research and dissemination to increase uptake of the technology. • Enhanced collaboration with other NARS, Higher Education Institutions for upscaling the technology and continued genetic improvement
Lessons learned	For increased yields to be realized form improved seed, should be adopted at a three-pronged approach i.e. (Quality seed + Quality feed + Management=Higher Yields). Quality affordable feed and water quality management should be monitored to give the improved seed the growth and survival performance experienced at the research trials and well operated private farms.
Social, environmental, policy and market conditions necessary	Reliable markets for improved fish breeds products and stable prices
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES. 8-10/- per fingerling
Estimated returns	Economic returns vary according production system
Gender issues and concerns in development and dissemination	Gender equity in provision of targeted information, practical demonstration,capacity building to all stakeholders on the application of technology.
Gender issues and concerns in adoption and scaling up	The technology easily be taken up by women and youth groups
Gender related opportunities	Youth and women can establish sustainable business enterprises which act as a source of income and livelihood
VMG issues and concerns in development and dissemination	This is a technology that can be easily be implemented by Vulnerable and Marginalized Groups
VMG issues and concerns in adoption and scaling up	The uptake by VMG is still low
VMG related opportunities	The VMG can establish aquaculture enterprises to act as a source of income and livelihood
E: Case studies/profiles of success stories	
Success stories	Sex reversal is the most widely adopted technique to produce monosex population using hormone treatment in Kenya and globally.
Application guidelines for users	Need for training manuals and guidelines on Nile tilapia genetic improvement and management
F. Status of TIMP readiness	Ready for upscaling

F: Contacts	
Contacts	Mr Jacob Abwao Kenya Marine and Fisheries Research Institute KMFRI P.O. Box 451-10230, Sagana abwaoj@yahoo.com
Lead organization and scientists	The project is being implemented by KMFRI Sagana Centre as the lead institution. The lead scientists are Dr Jonathan Munguti, Dr Paul Orina, Ms Mary Opiyo, Dr Kevin Obiero, Ms Domitila Kyule, Ms Jane Fonda, Ms Cecilia Muthoni, Mr Elijah Kembenya
Partner Organizations	• National Aquaculture Research and Development Training Centre • Machakos University • South Eastern Kenya University • Maseno University • Kenya Fisheries Service • County Governments • Model farmers • Private commercial farms

3.5.2 Artificial propagation of Catfish

Technology name	Artificial seed propagation of Catfish
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	Lack of seed production in captivity leads to poor growth yields and slow adoption of fish farming across the country.
What is it? (TIMP description)	Artificial propagation involves induced spawning in catfish yearround; after injection of hormones, the females develop eggs. In nature, catfish only spawn once annually during the rainy season. Selection of suitable males and females is done from brood-stock pond(s). Disinfection of the fish with a 50 to 150 ppm. formalin bath is done for 3 hours before bringing them to the hatchery to prevent pathogens from being transmitted to eggs and larvae. Females with soft swollen bellies with greenish eggs oozing from genital papillae are subjected to gentle pressing of abdominal region. A confirmatory test is done by measuring egg diameter and when about 90% of eggs are larger than 1.0 mm the females are ready.
Justification	The African catfish breeding season in the wild usually commences with the advent of the rains. The coming of the rains in tropical Africa is mainly characterized with extreme temperature fluctuations. These fluctuations could prevent high survival of the African Catfish fry. The fish does not breed in captivity
Region promoted	Country-wide

B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Input suppliers, Model authenticated hatcheries, women and youth groups, County Fisheries Departments, Kenya Fisheries Service, Government, Research and Higher Learning Institutions
Approaches used in dissemination	Individual farm visits, practical demonstrations of technology, training workshops/seminars, mass media, print media, social media, Agricultural shows and exhibitions, farmer field schools and farmer-to-farmer extension approach.
Critical/essential factors for successful promotion	Selection of suitable males and females from brood-stock pond(s). Disinfection of the fish with a 50 to 150 ppm. formalin bath for 3 hours before bringing them to the hatchery to prevent pathogens from being transmitted to eggs and larvae. Females with soft swollen bellies with greenish eggs oozing from genital papillae at gentle pressing of abdominal region are selected. A confirmatory test is to measure egg diameter and when about 90% of eggs are larger than 1.0 mm the females are ready.
Partners/stakeholders for scaling up	• Multipliers / Hatcheries to take up the improved breeds for multiplication and avail to farmers • Engagement of county governments to take up the technology and avail it to farmers for improved livelihoods—food and nutrition security, poverty alleviation and income generation.
C: Current situation and future scaling up	
Current extent of reach	Moderate (medium)
Challenges in dissemination	Inadequate extension and community outreach programs within the Counties
Recommendations for addressing the challenges	There is need for intensified GAPs training for hatchery operators, grow-out farmers and extension to the county level for fast and meaningful impact.
	• Improve KMFRI capacity to produce Broodstock and parental stock • Allocation of more funds for continued research and dissemination to increase uptake of the technology. • Enhanced collaboration with other NARS, Higher Education Institutions for upscaling the technology and continued genetic improvement
Lessons learned	For increased yields to be realized form improved seed, there is need to adopt a three-pronged approach i.e. (Quality seed + Quality feed + Management=Higher Yields). Quality affordable feed and water quality management should be strengthened to give the improved seed the growth and survival performance experienced at the research trials and well operated private farms.
Social, environmental, policy and market conditions necessary	Reliable markets for improved fish breeds products and stable prices
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES. 15/- per fingerling

Estimated returns	Economic returns vary according production system
Gender issues and concerns in development and dissemination	Gender equity in provision of targeted information, practical demonstration, capacity building to all stakeholders on the application of technology.
Gender issues and concerns in adoption and scaling up	The technology easily be taken up by women and youth groups
Gender related opportunities	Youth and women can establish sustainable business enterprises which act as a source of income and livelihood
VMG issues and concerns in development and dissemination	This is a technology that can be easily carried out by Vulnerable and Marginalized Groups
VMG issues and concerns in adoption and scaling up	The uptake by VMG is still low
VMG related opportunities	The VMG can establish aquaculture enterprises to act as a source of income and livelihood
E: Case studies/profiles of success stories	
Success stories	Sex reversal is the most widely adopted technique to produce monosex progeny is hormone treatment in Kenya and globally.
Application guidelines for users	Need for training manuals and guidelines on Nile tilapia genetic improvement and management
F: Contacts	
Contacts	Mr Jacob Abwao Kenya Marine and Fisheries Research Institute KMFRI P.O. Box 451-10230, Sagana abwaoj@yahoo.com
Lead organization and scientists	The project is being implemented by KMFRI Sagana Centre as the lead institution. The lead scientists are Dr Jonathan Munguti, Dr Paul Orina, Ms Mary Opiyo, Dr Kevin Obiero, Ms Domitila Kyule, Ms Jane Fonda
Partner Organizations	National Aquaculture Research and Development Training Centre
	Machakos University South Eastern Kenya University Kenya Fisheries Service County Governments Model farmers Private commercial farms

3.5.3 Temperature shock Tilapia & Goldfish

Technology name	**Temperature Induction**
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem to be addressed	Seed production is one of the key parameters for successful aquaculture business. However, some fish do not spawn in

	captivity and would need some form of induction using temperature.
What is it? (TIMP de for scription)	Temperature shock is a drastic change in temperature to induce some processes in fish. If there is a drastic change in temperature gold fish will be induced to spawn. Also, if the temperature changes rapidly the sex ratios will be altered in favour of one sex.
Justification	• Adequate seed supply is needed to increase aquaculture production • Mono-sex populations are required for grow-out of tilapias
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Hatcheries, Fish farmers, County Fisheries Departments, Kenya Fisheries Service
Approaches to be used in dissemination	Practical demonstrations of the technology to farmers, training workshops/seminars, mass media, print media, social media, Agricultural shows and exhibitions, farmer field schools and farmer-to-farmer extension approach.
Critical/essential factors for successful promotion	Room for rapid manipulation of temperature
C: Current situation and future scaling up	
Counties where already promoted (if any)	Kirinyanga County
Counties where TIMPs will be upscaled	Machakos, Makueni, central, Siaya, Kakamega, Busia Lamu.
Challenges in dissemination	Availability of funds, operation of RAS systems
Suggestions for addressing the challenges	• Enhanced collaboration with other NARS, Higher Education Institutions for upscaling the technology. Training farmers on Best Management Practices on Hatchery systems for increased upscale. • Improve selected farmers' capacity to Manage Hatcheries
Lessons learned in upscaling (if any)	Implemented in a limited scope
Social, environmental, policy and market conditions	Design suitable and user- friendly hatcheries for small farmer Provide training to facilitate uptake of the innovation.
necessary for development and upscaling	
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Low cost but is dependent on the size of the facility.
Estimated returns	Good returns.
Gender issues and concerns in development and dissemination	Targeting resource-poor and vulnerable households as recipients and small holder aquaculture groups and making concerted efforts to involve women in supply running of hatchery.
Gender issues and concerns in adoption and scaling up	In connection with women-targeted technologies, incorporating and training of family units in the implementation of the innovation
Gender related opportunities	Establishment of sustainable business enterprises, groups to supply fingerlings produced through the system to supplement income.

VMG issues and concerns in development and dissemination	This is an innovation that is easy to implement and therefore ideal for to Vulnerable and Marginalized Groups
VMG issues and concerns in adoption and scaling up	The uptake by VMG is low due to resources and information.
VMG related opportunities	The VMG can establish enterprises based on this innovation to generate revenue
E: Case studies/profiles of success stories	
Success stories from previous similar projects	On farm trials have been conducted at Sagana. Kirinyanga County
Application guidelines for users	Development of protocols, for training manuals and posters to simplify information on the running of such hatchery systems
F: Status of TIMP readiness 1. Ready for upscaling; 2. Require validation and 3. Require further research	Ready for Implementation and upscaling
G: Contacts	
Contacts	Prof. David Liti University of Eldoret P.O. Box 1125, Eldoret
Lead organization and scientists	The project is being implemented by KMFRI as the lead institution. Prof. David Liti *davidmbevaliti@gmail.com*
Partner Organizations	• Kenya Marine and Fisheries Research institute • Machakos University

Gaps

1. Need optimization of the system

3.5.4 Production of sterile stocks with plant extracts

Technology name	**Sterile Tilapia Stocks with plant extracts**
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem to be addressed	Culture of mixed-sex population of Nile tilapia results in overpopulation of culture with stunted individuals. Culture of fish do not spawn in captivity is necessary to avoid overpopulation of culture systems. Sterile stocks are normally produced using hormones. However, there have been concerns in the use of hormones in human food.
What is it? (TIMP de for scription)	Sterile stocks are those fish in which the gonads have been impaired in such a way they are not able to breed in culture facilities.
Justification	Plant extracts consist of highly degradable compounds and can easily be used in human food products without serious consequences on human health.
B: Assessment of dissemination and scaling up/out approaches	

Users of TIMP	Hatcheries, Fish farmers, County Fisheries Departments, Kenya Fisheries Service, Research and Higher Learning Institutions
Approaches to be used in dissemination	Practical demonstrations of the innovation to farmers, training workshops/seminars, mass media, print media, social media, farmer field days and farmer-to-farmer extension approach.
Critical/essential factors for successful promotion	Non-availability of toxic substances
C: Current situation and future scaling up	
Counties where already promoted (if any)	Uasin Gishu County
Counties where TIMPs will be upscaled	Siaya, Kakamega, Busia, Kisumu
Challenges in dissemination	Availability of funds
Suggestions for addressing the challenges	• Enhanced collaboration with other NARS, Higher Education Institutions for upscaling the technology. Training farmers on Best Management Practices on Hatchery systems for increased upscale. • Improve selected farmers' to raise sterile stocks
Lessons learned in upscaling (if any)	Not yet been implemented
Social, environmental, policy and market conditions necessary for development and upscaling	Design suitable and user- friendly protocols for small farmer Provide training to facilitate uptake of the innovation.
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Low cost innovation.
Estimated returns	High productivity.
Gender issues and concerns in development and dissemination	Targeting resource-poor and vulnerable households as recipients and small-scale aquaculture groups and making concerted efforts to involve production of sterile stocks.
Gender issues and concerns in adoption and scaling up	Incorporating and training family units in the implementation of the innovation, women play a major role in families.
Gender related opportunities	Establishment of small and sustainable fish farming business enterprises, establishing women and youth groups to supply fingerlings produced through the system to supplement income.
VMG issues and concerns in development and dissemination	This is an innovation that is easy to implement and with low cost investment, therefore ideal for to Vulnerable and Marginalized Groups
VMG issues and concerns in adoption and scaling up	The uptake by VMG is low due to resources and lack of information.
VMG related opportunities	The VMG can establish fingerling production systems based on this innovation to generate revenue
E: Case studies/profiles of success stories	
Success stories from previous similar projects	At pilot stage

Application guidelines for users	Development of protocols, for training manuals and posters to simplify information on the running of such hatchery systems
F: Status of TIMP readiness 1. Ready for upscaling; 2. Require validation and 3. Require further research	Ready for Implementation and upscaling
G: Contacts	
Contacts	Prof. David Liti University of Eldoret P.O. Box 1125, Eldoret
Lead organization and scientists	The project is being implemented by U.o.E as the lead institution. Prof. David Liti *davidmbevaliti@gmail.com*
Partner Organizations	• Kenya Marine and Fisheries Research institute • Machakos University • Kenya Fisheries Service

Gaps

1. Need further evaluation

3.6 Model Mini Hatchery

Technology name	**Model Mini Hatchery**
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem to be addressed	Lack of a small scale hatchery model that has the capability of producing certified high quality and affordable fish seed. Farmers spent a lot of cash and time to access quality seeds.
What is it? (TIMP description)	The design and construction of a mini model inexpensive hatchery to be adopted by local farmers to increase the quantity of certified seeds. Such hatcheries can easily be installed and effectively managed by farmers.
Justification	Demand for fish seed is on the rise especially due to the fact that many people are getting into fish farming enterprise. The demand for aquaculture products is steadily increasing in Kenya due the increasing human population and the need for Kenya to be food secure by the year 2030. Hatcheries can therefore produce enough
	seeds which can later be stocked in fish ponds and grown up to table size.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Input suppliers, women and youth groups, County Fisheries Departments and Kenya Fisheries Service
Approaches to be used in dissemination	Practical demonstrations on design, construction and management. Achieved through training workshops/seminars, mass media, print media and farmer-to-farmer extension approach.

Critical/essential factors for successful promotion	• Develop and design a mini hatchery model to increase access to improved fish seed • Best Management Practices for hatcheries
Partners/stakeholders for scaling up and their roles	• Potential Multipliers / Hatcheries to install these hatcheries and acquire high quality brood stock for the purpose of successful propagation. take up the improved breeds for multiplication and avail to farmers • Engagement of county governments to take up the technology and avail it to farmers for improved livelihoods—food and nutrition security, poverty alleviation and income generation.
C: Current situation and future scaling up	
Counties where already promoted. (if any)	Homa Bay, Kilifi, Kirinyaga, Kisii, Kitui, Laikipia, Machakos, Makueni, Meru, Nakuru, Nyeri, Muranga
Counties where TIMPs will be upscaled	Busia, Kakamega, Siaya, Lamu, Kisumu, Nyandarua (as prioritized by the target counties)
Challenges in dissemination	Inadequate extension and community outreach programs within the Counties
Suggestions for addressing the challenges	• There is need for intensified GAPs training for hatchery operators and extension officers to the county level for fast and meaningful impact. • Allocation of more funds for continued research and dissemination to increase uptake and adoption of the innovation. • Enhanced collaboration with other NARS, Higher Education Institutions for upscaling the innovation
Lessons learned in upscaling (if any)	High production of fry but this is pegged on water quality issues, Broodstock quality, hatchery management procedures, fish nutrition, Broodstock management.
Social, environmental, policy and market conditions necessary for development and upscaling	Reliable markets for improved fish seeds and stable prices
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES. 10/- per fingerling
Estimated returns	Varies according production system (Excel Table to be developed for cost calculations)
Gender issues and concerns in development and dissemination	This technology dissemination process ensured 50% representation of women, youth and vulnerable groups in decision-making processes; and provision of targeted information, education, capacity building to all stakeholders regarding gender awareness as well as on HIV, nutrition and related social aspects.
Gender issues and concerns in adoption and scaling up	The technology can easily be taken up by women and youth groups
Gender related opportunities	Youth and women can establish sustainable aquaculture business enterprises which act as a source of income and livelihood
VMG issues and concerns in development and dissemination	This is a technology that can be easily carried out by Vulnerable and Marginalized Groups

VMG issues and concerns in adoption and scaling up	The uptake by VMG is still low
VMG related opportunities	The VMG can establish aquaculture enterprises to generate income and livelihood
E: Case studies/profiles of success stories	
Success stories	Farmers in Kirinyaga, Homabay, Kisii, Kakamega and Kisii have successfully bred both African catfish and Nile tilapia with hatchability ranging from 50 to 90%. Farmers who adopted this technology have had sustained source of income and livelihood
Application guidelines for users	There is need for training manuals and guidelines on Nile tilapia breeding improvement and management techniques
F: Status of TIMP readiness	Ready for upscaling
G: Contacts	
Contacts	Centre Director, Sagana Aquaculture Centre Kenya Marine and Fisheries Research Institute KMFRI P.O. Box 451-10230, Sagana kmfrinardtc@gmail.com
Lead organization and scientists	The project is being implemented by KMFRI Sagana Centre as the lead institution. The lead scientists are Dr Jonathan Munguti, Dr Kevin Obiero, Ms Mary Opiyo, Ms Domitila Kyule, Cecilia Muthoni, Mr Jacob Abwao, Jane Fonda, Elijah Kembenya and Robert Ondiba
Partner Organizations	• Karatina University • University of Eldoret • Kenya Fisheries Service • National Aquaculture Research and Development Training Centre • County Governments.

4.0 Fish Feeds and Feeding Management

4.1 Biofloc technology

Technology name	**Biofloc based aquaculture systems**
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	
What is it? (TIMP description)	Biofloc is an aquaculture system, which focuses on an efficient use of nutrient input with minimal or zero water exchange. The main
	principle of BFT is to recycle nutrient by maintaining a high carbon / nitrogen (C/N) ratio in the water to stimulate heterotrophic bacterial growth that converts ammonia into microbial biomass under optimal temperature. Bacterial growth increases when carbon source such as wheat bran, molasses or cellulose is sprayed on the surface of pond water with continuous aeration. Using feeds with a carbon to nitrogen (C/N) ratio greater than 15 results in the

	dominance of heterotrophic bacteria, which then becomes food source for culture fishes.
Justification	The biofloc system is an intensive aquaculture system, in which biofloc or bacterial floc is introduced into reinforced geomembrane lined aquaculture ponds, which convert the waste eliminated by aquatic creatures into edible mass. This edible mass is rich in protein (50 to 65 % on dry matter basis), Vitamins, micronutrients and has probiotic effect. Biofloc contains 96 % water. It improves the immune system of the aquatic animal. Usually in the traditional system, conversion ratio of fish: feed on both dry matter basis is 1:4.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Hatchery operators, fish farmers, cottage feed producers
Approaches used in dissemination	Farmer to formers, mass media, practical demonstration, print media, model farmers
Critical/essential factors for successful promotion	• Well-developed decentralized culture systems to pass over the technology to fish farmers • Complementary technologies to support the biofloc culture systems
Partners/stakeholders for scaling up	Farmers, Model authenticated hatcheries, women and youth groups, County Fisheries Departments, Kenya Fisheries Service, National Government Agencies dealing with promotion of food security, Tertiary training institutions teaching aquaculture, (Sagana Fisheries School, KWSTI, RIAT) Research and Higher Learning Institutions.
C: Current situation and future scaling up	
Counties where TIMP already promoted, if any	Kirinyaga, Kisumu, Machakos, Kitui, Meru, Makueni, Migori, Kakamega, Nakuru, Kilifi
Counties where TIMP to be upscaled	Kisumu, Kisii, Nyamira, Vihiga, Migori, Siaya, Nyandarua
Challenges in dissemination	• Lack of simple dissemination materials (Booklets, brochure, Posters, fact sheets) • Inadequate extension and community outreach programs within the Counties for new technologies
Suggestions for addressing the challenges	• There is need for intensified GAPs training for farmers, growout farmers and extension to the county level for fast and meaningful impact. • Improve KMFRI capacity to produce dissemination material and have on farm demonstration sites at county levels • Allocation of more funds for continued research and dissemination to increase uptake of the technology.
Lessons learned	For increased yields to be realized from Biofloc technology, we should adopt a three-pronged approach i.e. Quality seed + Quality
	feed + Management=Higher Yields. Quality affordable seed and water quality management should be provided in fish farms for optimal outputs in the biofloc technology

Social, environmental, policy and market conditions necessary	• Design Biofloc culturing units that are women appropriate (e.g. size and affordability). • Test how technologies fit with social realities, instead of focusing only on technical solutions. • Provide additional support (e.g. credit) to facilitate independent uptake
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	
Estimated returns	Economic returns vary according production system (size, bacterial matter)
Gender issues and concerns in development and dissemination	Gender equity in provision of targeted information, practical demonstration, capacity building to all stakeholders on the application of technology
Gender issues and concerns in adoption and scaling up	The technology easily be taken up by women and youth groups
Gender related opportunities	Affirmative action that is provided for under the Kenyan constitution for women, youth and other VMGs and also the fact that agriculture in the country is driven by women and youth
VMG issues and concerns in development and dissemination	This is a technology that can be easily carried out by Vulnerable and Marginalized Groups
VMG issues and concerns in adoption and scaling up	The uptake by VMG is still low
VMG related opportunities	The VMG can establish aquaculture enterprises to act as a source of income and livelihood
E: Case studies/profiles of success stories	
Success stories	Biofloc technology is the most widely adopted technique in Asian countries in aquaculture production, the technology has been tested in the country with great success in Nyanza, Eastern, Central and Coast regions
Application guidelines for users	Development of fact sheets, training manuals and posters to simplify the breeding protocols and guidelines for Catfish cross breeding and genetic improvement
F: Contacts	
Contacts	Dr Jonathan Munguti Kenya Marine and Fisheries Research Institute KMFRI P.O. Box 451-10230, Sagana Jmunguti2000@gmail.com
Lead organization and scientists	The project is being implemented by KMFRI Sagana National Aquaculture Research Centre as the lead institution. The lead scientists are Dr. Jonathan Munguti, Ms Mary Opiyo, Dr Kevin Obiero, Ms Domitila Kyule, Ms Jane Fonda, Mr. Elijah Kembenya, Ms Cecilia Githukia
Partner organizations	• Kenya Fisheries Service • Machakos University • South Eastern Kenya University

	• National Aquaculture Research and Development Training Centre • County Governments. • Other NARs and Genetic Improvement Centres in Kenya

4.2 Use of live feeds for larval rearing

4.2.1 Artemia

Technology name	**Artemia**
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	Low fish fry/ juvenile survival for most fish species (African catfish, trout, milk fish, mullets)
What is it? (TIMP description)	*Artemia* is a cosmopolitan crustacean typically adapted to live in stressful environmental conditions of hypersaline habitats such as salt lakes, coastal lagoons and solar saltworks. Among the live diets used in the larviculture of fish and shellfish, *Artemia* nauplii constitute the most widely used food item. Indeed, the unique property of *Artemia* including the evolution of two distinctly different paths of development, which includes the production of diapausing cysts during harsh environmental conditions and the directly developing embryos during favourable conditions make them convenient, suitable and excellent larval food source.
Justification	*Artemia* nauplii are the best live food for fish larviculture. Hatching of *Artemia* fry is possible using artificially prepared seawater. This is affordable for most farmers
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Hatchery operators, fish farmers
Approaches to be used in dissemination	Farmer to formers, mass media, practical demonstration, print media, model farmers
Critical/essential factors for successful promotion	• PPP model, Good Aquaculture practices (GAqPs), capacity building for farmers producing the artemia • Well-developed decentralized artemia breeding programs within the coastal riparian (Lamu, Kilifi, Mombasa, Kwale) to increase access to artemia cysts to hatchery operators • Complementary technologies from value quality services and reliable markets
Partners/stakeholders for scaling up	Farmers, Model authenticated hatcheries, women and youth groups, County Fisheries Departments, Kenya Fisheries Service, National Government Agencies dealing with promotion of food security, Tertiary training institutions teaching aquaculture, (Sagana Fisheries School, KWSTI, RIAT) Research and Higher Learning Institutions

C: Current situation and future scaling up	
Counties where TIMP has been promoted, if any	High – many successful on-station and on-farm experiments in North Coast (Malindi, Ngomeni, Kongoni) Several technical
	reports developed, A policy brief developed and forwarded to PS Fisheries
Counties where TIMP is to be upscaled	Lamu, Siaya, Kisumu, Siaya
Challenges in dissemination	Lack of extension, inadequate funding, sophisticated technology, expensive processing machine
Recommendations for addressing the challenges	County government investing in processing equipment, Engagement of private fish farms to uptake the technology
Lessons learned	Organizing farmers into registered clusters
Social, environmental, policy and market conditions necessary	• Design artemia culturing units that are women appropriate (e.g. size and affordability). • Test how technologies fit with social realities, instead of focusing only on technical solutions. • Provide additional support (e.g. credit) to facilitate independent uptake • Ensure reliable markets for improved fish breeds products and stable prices
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	
Estimated returns	Economic returns vary according production system (size, bacterial matter)
Gender issues and concerns in development and dissemination	Gender equity in provision of targeted information, practical demonstration, capacity building to all stakeholders on the application of technology
Gender issues and concerns in adoption and scaling up	The technology is user friendly for women and youth groups
Gender related opportunities	Affirmative action that is provided for under the Kenyan constitution for women, youth and other VMGs and the fact that agriculture in the country is driven by women and youth
VMG issues and concerns in development and dissemination	This is a technology that can be easily carried out by Vulnerable and Marginalized Groups
VMG issues and concerns in adoption and scaling up	The uptake by VMG is still low
VMG related opportunities	The VMG can establish aquaculture enterprises to act as a source of income and livelihood
E: Case studies/profiles of success stories	
Success stories	Successfully established artemia production established in Kilifi County in Ngomeni and Kongoni, cultured, packaged ready for upscaling.
Application guidelines for users	Development of fact sheets, training manuals and posters to simplify the artemia breeding protocols and guidelines for hatchery users

F. Status of TIMP readiness	Ready to upscale
G: Contacts	
Contacts	Ms Morine Mokami Kenya Marine and Fisheries Research Institute KMFRI P.O Box 81651-80100 Mombasa, Kenya morinemukamik@gmail.com
Lead organization and scientists	The project is being implemented by KMFRI Mombasa Centre as the lead institution. The lead scientists are Dr. Jonathan Munguti, Mourine Mukami,Dr. Mirera, Dr. James Mwaluma, Miriam Wainaina, Esther Wairimu,
Partner organizations	• Kenya Fisheries Service • Machakos University • South Eastern Kenya University • National Aquaculture Research and Development Training Centre • County Governments. • Other NARs and Genetic Improvement Centres in Kenya

4.2.2 Rotifers

Technology name	**Rotifers**
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	Low fish fry/ juvenile survival for most fish species (African catfish, trout, milk fish, mullets)
What is it? (TIMP description)	Rotifers (*Brachionus spp*) is the first choice in larval fish diets due to their small size (90-350 µm), It has high capacity for nutritional enrichment, and high reproductive rates. Today, the Kenyan rotifer strain *Brachionus angularis* is so far the smallest (lorica length: 85.6±3.1 µm; width: 75.4±3.6 µm) and, reproduces optimally at 25^{o}C with 2.5×106 algal cells ml-1; thus, convenient for feeding small-mouth freshwater fish larvae.
Justification	Because of their favorable reproductive attributes, the demand for rotifers has increased, prompting more investigations into convenient culture techniques to ensure consistent supply in hatcheries. Apparently, the cost of production is the main factor that determines rotifer availability.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Hatchery operators, fish farmers
Approaches to be used in dissemination	Farmer to formers, mass media, practical demonstration, print media, model farmers
Critical/essential factors for successful promotion	• PPP model, Good Aquaculture practices (GAqPs), capacity building for farmers producing the rotifers

	• Well-developed decentralized rotifer breeding programs within the Lake Victoria riparian counties (Siaya, Kisumu, Busia, Homabay, Migori) to increase access to rotifer to hatchery operators supplying the cages with fingerings
Partners/stakeholders for scaling up	KeFS, Universities, Aquaculture tertiary training institute (Sagana, RIAT, KWSTI), County Governments, private large-scale fish farms
C: Current situation and future scaling up	
Counties where TIMP already promoted, if any	Kilifi, Kwale and Mombasa
Counties where TIMP to be upscaled	Lamu, Kisumu, Siaya, Kakamega
Challenges in dissemination	Lack of extension materials- (brochure, booklets, factsheets, posters), inadequate funding, sophisticated technology, expensive processing machine
Recommendations for addressing the challenges	County government investing in processing equipment
Lessons learned	Organizing farmers into registered clusters
Social, environmental, policy and market conditions necessary	• Design artemia culturing units that are women appropriate (e.g. size and affordability). • Test how technologies fit with social realities, instead of focusing only on technical solutions. Provide additional support (e.g. credit) to facilitate independent uptake • Ensure reliable markets for improved fish breeds products and stable prices
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Not yet determined
Estimated returns	Economic returns vary according production system (size, bacterial matter)
Gender issues and concerns in development and dissemination	Gender equity in provision of targeted information, practical demonstration, capacity building to all stakeholders on the application of technology
Gender issues and concerns in adoption and scaling up	The technology easily be taken up by women and youth groups
Gender related opportunities	Affirmative action that is provided for under the Kenyan constitution for women, youth and other VMGs and the fact that agriculture in the country is driven by women and youth
VMG issues and concerns in development and dissemination	This is a technology that can be easily carried out by Vulnerable and Marginalized Groups
VMG issues and concerns in adoption and scaling up	The uptake by VMG is still low
VMG related opportunities	The VMG can establish aquaculture enterprises to act as a source of income and livelihood
E: Case studies/profiles of success stories	
Success stories	Not yet recorded

Application guidelines for users	Development of fact sheets, training manuals and posters to simplify the breeding protocols and guidelines
F. Status of TIMP readiness	Ready to upscale
F: Contacts	
Contacts	Dr Jonathan Munguti, Kenya Marine and Fisheries Research Institute KMFRI P.O. Box 451-10230, Sagana | Jmunguti2000@gmail.com
Lead organization and scientists	The project is being implemented by KMFRI Sagana Centre as the lead institution.
	The lead scientists are Dr. Jonathan Munguti, Dr. Paul Orina, Ms Mary Opiyo, Dr Kevin Obiero, Ms Domitila Kyule, Ms Jane Fonda
Partner organizations	• Kenya Fisheries Service • Machakos University • South Eastern Kenya University • County Governments. Other NARs and Genetic Improvement Centres in Kenya

4.3 Plant seed cake-based protein sources in fish diets

Technology name	**Plant seed cake-based protein sources in fish diets**
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem to be addressed	Fish feeds are important in aquaculture production and account for more than 60% of total operational costs. To facilitate sustainable aquaculture growth, research geared towards reducing the costs will play a key role in promoting the sector. Animal protein sources have been identified as the most expensive input in fish feeds, specifically fishmeal which has been used for decades. Therefore, there is need to find cheap and cost-effective alternative protein sources which can substitute fishmeal partially or completely with the aim of achieving same growth performance.
What is it? (TIMP description)	Formulations of fish feed diets using a combination of seedcakes (Copra/coconut, ground nut, sunflower, seaweed, cottonseed and soya bean) to replace fishmeal have been developed.
Justification	Plant proteins are considered economically valuable because of their low cost and relative abundance. Plant protein possess characteristics such as high protein levels, nutrient digestibility, good palatability, low fibre and anti- nutritional factors.Plant proteins sources which have been investigated as potential fishmeal replacements include, cottonseed cake, soybean cake and Sunflower cake.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Cottage feed producers, Hatchery operators, fish farmers

Approaches used in dissemination	Farmer to farmers, mass media, practical demonstration, print media, model farmers
Most effective approach	Practical demonstration and production by cottage feed producers
Critical/essential factors for successful promotion	• Well-developed decentralized feed processing units to increase access to effective and cost-effective feeds to fish farmers • Complementary technologies in processing drying and storage of fish feeds
Partners/stakeholders for scaling up	• Cottage fish feed producers, • Aquaculture tertiary Training Institute (Sagana Fisheries School, Ramogi Institute of Agriculture Technology (RIAT), Kenya World Life Training Institute (KWSTI),
	• County Governments, • Private fish farms, • Kenya Fisheries Service (KeFS), • Aquaculture Association of Kenya (AAK)
C: Current situation and future scaling up	
Counties where TIMP already promoted	Taita-Taveta, Kirinyaga, Kisumu, Machakos, Kitui, Meru, Makueni, Migori, Vihiga, Kakamega, Nakuru, Kilifi, Kisii, Nyamira, Homabay, Nyeri, Embu, Tharaka Nithi, Kwale
Counties where TIMP to be upscaled	Lamu, Kisumu, Siaya, Nyandarua, Kamamega
Challenges in dissemination	High cost of ingredients, limited knowledge in formulations, inadequate funding
Suggestions for addressing the challenges	Working closely with County government investing in processing equipment, working with registered women and youth groups.
Lessons learned	Ensure the right formulations are used, proper processing of feeds to ensure homogeneity Organizing farmers into registered clusters
Social, environmental, policy and market conditions necessary	• Design plant seed cake-based fish diets culturing units that are women and youth appropriate (affordability, size). • Test how technologies fit with social realities, instead of focusing only on technical solutions. • Provide additional support (e.g. credit) to facilitate independent uptake • Ensure reliable markets for improved fish breeds products and stable prices • Reliable markets for improved fish breeds products and stable prices • Organized registered groups, zero rated cost of feed ingredients
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	
Estimated returns	
Gender issues and concerns in development and dissemination	Gender equity in provision of targeted information, practical demonstration, capacity building to all stakeholders on the application of technology
Gender issues and concerns in adoption and scaling up	The technology easily be taken up by women and youth groups

Gender related opportunities	Youth groups can open enterprises
VMG issues and concerns in development and dissemination	This is a technology that can be easily carried out by Vulnerable and Marginalized Groups
VMG issues and concerns in adoption and scaling up	The uptake by VMG is still low
VMG related opportunities	The VMG can establish aquaculture enterprises to act as a source of income and livelihood
E: Case studies/profiles of success stories	
Success stories	Successful establishment of rotifer production at KMFRI Sangoro Centre and Kegati Station ready for upscaling
Application guidelines for users	Development of fact sheets, training manuals and posters to simplify the breeding protocols and guidelines for hatchery operators
Status of TIMP readiness	Ready to upscale
F: Contacts	
Contacts	Dr Jonathan Munguti Kenya Marine and Fisheries Research Institute KMFRI P.O. Box 451-10230, Sagana Jmunguti2000@gmail.com
Lead organization and scientists	The project is being implemented by KMFRI Sagana Centre as the lead institution. The lead scientists are Dr. Jonathan Munguti, Mary Opiyo, Dr Kevin Obiero, Domitila Kyule, Jane Fonda, Cecilia Githuka, Elijah Kembenya, Robert Ondiba, Safina Musa, Jacob Abwao
Partner organizations	• Kenya Fisheries Service • Machakos University • South Eastern Kenya University • National Aquaculture Research and Development Training Centre • County Governments. • Other NARs and Genetic Improvement Centres in Kenya

4.4 Insect Based protein sources in fish diets as replacement of fishmeal –Black Soldier Fly larvae, Maggot meal and termite meal

Technology name	**Use of Black Soldier Fly (BSF) Larvae, maggots and termites in replacement of fishmeal in culture fish diets**
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem to be addressed	Fish feeds are important in aquaculture production and account for more than 70% of total operational costs. Animal protein sources have been identified as the most expensive input in fish feeds,

	specifically fishmeal that has been used for decades. Therefore, research geared towards finding alternative protein sources will lower the cost of fish feeds, boost profit margins and promote fish farming in the country.
What is it? (TIMP description)	Formulations of fish feed diets using insect-based protein sources in replacement of expensive fishmeal in diets of cultured fish species. The innovation utilizes BSF which is grown using waste (Kitchen waste, chicken droppings, cow dung)
Justification	Black soldier fly (BSF) larvae has excellent characteristics for waste management tool and as a highly nutritious feed compound which is viable reasons for its adoption by farmers and institutions dealing with waste management and fish. Cured BSF larvae contain 42 percent CP and 35 percent crude fat on dry matter basis. Live BSF larvae have a 44 percent DM. Besides being seasonal insects, during rainy season, termites swam in large numbers and can be harvested
	for fish feed production; they have a crude protein level of 46.3% and ash content of 3.6%. Maggot meal like the black soldier fly are raised from waste and also contain high crude protein levels of 47.6%, ash content of 6.25% and 25.3% crude fat.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Cottage feed producers, commercial feed factories, Hatchery operators, fish farmers
Approaches used in dissemination	Farmer to formers, mass media, practical demonstration, print media, model farmers
Critical/essential factors for successful promotion	PPP model, Good Aquaculture practices (GAqPs), capacity building for cottage feed producers Well-developed decentralized breeding program to increase access to improved breed availability
Partners/stakeholders for scaling up	Cottage fish feed producers, Aquaculture tertiary Training Institute (Sagana Fisheries School, Ramogi Institute of Agriculture Technology (RIAT), Kenya World Life Training Institute (KWSTI), County Governments, Private fish farms, Kenya Fisheries Service (KeFS), Aquaculture Association of Kenya (AAK)
C: Current situation and future scaling up	
Counties where TIMP already promoted	Taita-Taveta, Kirinyaga, Kisumu, Machakos, Kitui, Meru, Makueni, Migori, Vihiga, Kakamega, Nakuru, Kilifi, Kisii, Nyamira, Homabay, Nyeri, Embu, Tharaka Nithi, Kwale
Counties where TIMP is to be upscaled	Busia, Kisumu, Siaya, Kakamega, Lamu, Nyandarua
Challenges in dissemination	Ethical issues, acquisition of enough volumes for commercialization, limited knowledge in formulations, inadequate funding
Recommendations for addressing the challenges	Working closely with County government investing in processing equipment, working with registered women and youth groups.

Lessons learned	Two (2) Formulation using Black soldier fly (BSF) larvae as the key source of animal protein source and tested on Nile tilapia and African catfish on growth and economic performance Ensure the right formulations are used, proper processing of feeds to ensure homogeneity Organizing farmers into registered clusters
Social, environmental, policy and market conditions necessary	• Design BSF culturing units that are women appropriate (e.g. size and affordability). • Test how technologies fit with social realities, instead of focusing only on technical solutions. • Provide additional support (e.g. credit) to facilitate independent uptake • Ensure reliable markets for improved fish breeds products and stable prices • Organized registered groups, zero rated cost of feed ingredients • Reliable markets for improved fish breeds products and stable prices
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	
Estimated returns	Economic returns vary according production system (size, type and amount of culture material used and temperature regimes)
Gender issues and concerns in development and dissemination	Gender equity in provision of targeted information, practical demonstration, capacity building to all stakeholders on the application of technology
Gender issues and concerns in adoption and scaling up	The technology easily be taken up by women and youth groups
Gender related opportunities	Affirmative action that is provided for under the Kenyan constitution for women, youth and other VMGs and the fact that agriculture in the country is driven by women and youth Youth groups can open enterprises
VMG issues and concerns in development and dissemination	This is a technology that can be easily carried out by Vulnerable and Marginalized Groups
VMG issues and concerns in adoption and scaling up	The uptake by VMG is still low
VMG related opportunities	The VMG can establish aquaculture enterprises to act as a source of income and livelihood
E: Case studies/profiles of success stories	
Success stories	BSF Culture is currently the biggest success stories in the replacement of Fishmeal in (fish, diary, poultry) diets. The results has attracted 3 commercial investors in Kenya, Unga Feeds (FUGO) brand is utilizing BSF Larvae as a key animal protein source in diet formulations.
Application guidelines for users	Development of fact sheets, training manuals and posters to simplify the breeding protocols and guidelines for Catfish cross breeding and genetic improvement
F: Status of TIMP readiness	Ready to upscale

G: Contacts	
Contacts	Dr Jonathan Munguti Kenya Marine and Fisheries Research Institute KMFRI P.O. Box 451-10230, Sagana Jmunguti2000@gmail.com
Lead organization and scientists	The project is being implemented by KMFRI Sagana Centre as the lead institution. The lead scientists are Dr. Jonathan Munguti, Dr. Paul Orina, Ms Mary Opiyo, Dr Kevin Obiero, Ms Domitila Kyule, Ms Jane Fonda
Partner organizations	• Kenya Fisheries Service • South Eastern Kenya University • National Aquaculture Research and Development Training Centre • County Governments. • Other NARs and Genetic Improvement Centres in Kenya

4.5 Cost effective feed formulations (starter, Grow-out & Finisher) fish feeds

Technology name	Cost effective feed formulations (starter, Grow-out & Finisher) feeds
Category (i.e. technology, innovation or management practice)	Complimentary technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	Fish feeds are important in aquaculture production and account for more than 60% of total operational costs. The lack of stage specific fish diets formulated using locally available feed ingredients results to feed wastage and high cost of running a fish farming business.
What is it? (TIMP description)	Species and growth stage specific diets (Formulations of fish feed diets for different stages of development starter, grow-out and finisher diets Brood stock diets
Justification	Fish feeds are important in aquaculture production and account for more than 60% of total operational costs. Lack of stage specific diets has resulted to feed wastage, compromised water quality resulting to poor fish growth and low profit margins and at times loses to farmers.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Cottage feed producers, commercial feed factories, Hatchery operators, fish farmers
Approaches used in dissemination	Farmer to formers, mass media, practical demonstration, print media, model farmers
Most effective approach	Practical demonstration and production by cottage feed producers
Critical/essential factors for successful promotion	• PPP model, Good Aquaculture practices (GAqPs), capacity building for cottage feed producers

	• Well-developed decentralized feed production units at County level focusing on locally available feed ingredients for starter, grow –out and finisher diets.
Partners/stakeholders for scaling up	Cottage fish feed producers, Aquaculture tertiary Training Institute (Sagana Fisheries School, Ramogi Institute of Agriculture Technology (RIAT), Kenya World Life Training Institute (KWSTI), County Governments, Private fish farms, Kenya Fisheries Service (KeFS), Aquaculture Association of Kenya (AAK)
C: Current situation and future scaling up	
Current extent of reach	
	Kirinyaga, Taita-Taveta, Kisumu, Machakos, Kitui, Meru, Makueni, Migori, Vihiga, Kakamega, Nakuru, Kilifi, Kisii, Nyamira, Homabay, Nyeri, Embu, Tharaka Nithi, Kwale
Challenges in dissemination	Quality of ingredients, unstable costs for ingredients, processing methods and certification by Kenya Bureau of standards (KEBS), limited knowledge in formulations, inadequate funding
Suggestions for addressing the challenges	Capacity building, sourcing of raw materials, feed processing and storage, working closely with County government investing in processing equipment, working with registered women and youth groups, introducing feed processing as a business venture for youth and other organized groups
Lessons learned	Ensure the right formulations is adhered to in feed processing, proper processing of feeds to ensure homogeneity Organizing farmers into registered clusters.
Social, environmental, policy and market conditions necessary	• Design production units for starter, grow-out and finisher diets that are women and youth appropriate (size and affordability). • Test how technologies fit with social realities, instead of focusing only on technical solutions. • Provide additional support (e.g. credit) to facilitate independent uptake • Ensure reliable markets for improved fish breeds products and stable prices
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	
Estimated returns	Economic returns vary according production system and protein inclusion in the diets
Gender issues and concerns in development and dissemination	Gender equity in provision of targeted information, practical demonstration, capacity building to all stakeholders on the application of technology
Gender issues and concerns in adoption and scaling up	The technology easily be taken up by women and youth groups
Gender related opportunities	Youth and women groups can open feed production and supply enterprises

VMG issues and concerns in development and dissemination	This is a technology that can be easily carried out by Vulnerable and Marginalized Groups
VMG issues and concerns in adoption and scaling up	The uptake by VMG is still low
VMG related opportunities	The VMG can establish aquaculture enterprises to act as a source of income and livelihood
E: Case studies/profiles of success stories	
Success stories	Three (3) Formulation using locally available feed ingredients for starter, grow-out and finisher diets and tested on Nile tilapia and African catfish, Marine tilapia and milkfish formulations ongoing on growth, survival and economic performance
Application guidelines for users	Need for training manuals and guidelines on fish feed production for starter, grow –out and finisher diets Development of fact sheets, posters to simplify the feed production and guidelines starter, grow –out and finisher diets
F: Contacts	
Contacts	Dr Jonathan Munguti Kenya Marine and Fisheries Research Institute KMFRI P.O. Box 451-10230, Sagana Jmunguti2000@gmail.com
Lead organization and scientists	The project is being implemented by KMFRI Sagana Centre as the lead institution. The lead scientists are Dr. Jonathan Munguti, Dr. Paul Orina, Ms Mary Opiyo, Dr Kevin Obiero, Ms Domitila Kyule, Ms Jane Fonda, Esther Wairimu
Partner organizations	• SDF & BE National Aquaculture Center, County • Governments, cottage feed producers, model farmers • Kenya Fisheries Service • Machakos University • South Eastern Kenya University • National Aquaculture Research and Development Training Centre • County Governments. • Other NARs and Genetic Improvement Centres in Kenya

4.6 Fish feed management and Feeding Strategies

Complimentary name	**Fish feed management and Feeding Strategies**
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	Fish feeds are important in aquaculture production and account for more than 70% of total operational costs. Poor feed management

	practices has resulted to feed wastage, low profit margins and at times loses in fish farming ventures
What is it? (TIMP description)	On farm fish feed management and feeding strategies to promote aquaculture production
Justification	In aquaculture systems, feed costs typically account for more than 70% of production costs. In order to ensure profitability, it is imperative that farmers have access to good quality feeds at reasonable prices, and that they optimize their feed use by instituting appropriate on-farm feed management practices
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Private fish farms (small, medium and Large), cottage feed producers, hatchery operators,
Approaches used in dissemination	Farmer to farmers model, mass media, practical on farm demonstration, print and mass media,
Most effective approach	Practical demonstration of feed management and feeding strategies for model farmers at county level for fast adoption by other farmers
Critical/essential factors for successful promotion	PPP model, Good Aquaculture practices (GAqPs), capacity building for farm managers and hatchery operators Well-developed decentralized on-farms model demonstration sites for farmers to learn from fellow farmers
Partners/stakeholders for scaling up	• County model fish farms • Cottage fish feed producers • Aquaculture tertiary Training Institute (Sagana Fisheries School, Ramogi Institute of Agriculture Technology (RIAT), Kenya World Life Training Institute (KWSTI), • County Governments • Private fish farms, • Kenya Fisheries Service (KeFS)
	Aquaculture Association of Kenya (AAK)
C: Current situation and future scaling up	
Counties where promoted	Taita-taveta, Kirinyaga, Kisumu, Machakos, Kitui, Meru, Makueni, Migori, Vihiga, Kakamega, Nakuru, Kilifi, Kisii, Nyamira, Homabay, Nyeri, Embu, Tharaka Nithi, Kwale
Counties to upscale TIMP	Busia, Kisumu, Siaya, Lamu
Challenges in dissemination	Limited knowledge for farmer record keeping, Quality of ingredients, processing methods consistency of farm practice by farmers, limited knowledge in feeding strategies, poor monitoring and evaluation mechanisms in fish farms
Recommendations for addressing the challenges	Capacity building for farmers, development of simple record keeping forms, feed processing and storage, working closely with County Fisheries Departments, working with registered women and youth groups
Lessons learned	The use of model fish farmers at county level, farmers learn faster from other farmers. Constant monitoring of fish farms, capacity

	building of extension officers and model farmers is key to any successful fish farming venture.
Social, environmental, policy and market conditions necessary	• Formulate and modify fish farm management practices, which are women and youth appropriate. • Procuring the right attire for use in fish farms such as waders, gloves and other protective gears • Guidelines in the use for hormones and other chemicals and disposal mechanisms • Test how technologies fit with social realities, instead of focusing only on technical solutions.
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	
Estimated returns	Economic returns vary according management practice and feeding strategies, the size of the farm, stocking densities, water quality management
Gender issues and concerns in development and dissemination	Gender equity in provision of targeted information, practical demonstration in farm management, employment of different feeding strategies which are user friendly (automated) capacity building to all stakeholders on the application of the management technology
Gender issues and concerns in adoption and scaling up	The technology easily be taken up by women and youth groups
Gender related opportunities	Youth and women groups can open feed production and supply enterprises
VMG issues and concerns in development and dissemination	Most management practices and feeding technologies in fish farms can be easily carried out by Vulnerable and Marginalized Groups such as automation
VMG issues and concerns in adoption and scaling up	The uptake by VMG is moderate
VMG related opportunities	The VMG can establish aquaculture enterprises to act as a source of income and livelihood by use of automated systems
E: Case studies/profiles of success stories	
Success stories	Several feed managements (feed formulation, processing and storage) and feeding strategies (broadcast, staged, automated and demand) have been identified and successfully tested for improved aquaculture production
Application guidelines for users	Development of guidelines in feed management and feeding strategies, fact sheets, booklets, brochure training manuals and posters to simplify the farm management
F: Contacts	
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Lead organization and scientists	The project is being implemented by KMFRI Sagana Centre as the lead institution.

	The lead scientists are Dr. Jonathan Munguti, Mary Opiyo, Dr Kevin Obiero, Domitila Kyule, Ms Jane Fonda
Partner organizations	• County Governments, Cottage feed producers, • Model farmers • Aquaculture Association of Kenya • Kenya Fisheries Service • Karatina University • JKUAT • Machakos University • South Eastern Kenya University (SEKU) • National Aquaculture Research and Development Training Centre (NARDTC)

5.0 Fish Health and Biosecurity

5.1 Prophylactic treatments (saline and Potassium permanganate solution)

Technology name	**Prophylactic treatments**
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem to be addressed	With the current accelerated growth of aquaculture in Kenya, there is increased translocation, handling and intensification of seed and feed application. As a result, fish diseases have become common leading to huge mortalities. Causative factors usually stem from malnutrition, viral, bacterial, fungal and parasitic infections resulting in poor growth, mortalities or lack of market.
What is it? (TIMP description)	Probiotics are feed supplements and immune-stimulants. Administration of probiotics and yeast containing glucans through immersion, dietary inclusion or injection has been found to enhance many types of immune responses, resistance to bacterial and viral infections and to environmental stress in many fish species. Most farmers make use of common salt for the treatment of fungal infections and some bacterial diseases like fin rot. During the
	incubation of the eggs and free-swimming larvae, treatment with common salt (Sodium chloride) 0.1–0.2 ppm once a day is usually effective to deter further *Saprolegnia* infections. Fry and fingerlings can be treated with 20–25 ppm formalin or 2 ppm potassium permanganate. Some protozoa also cause disease in fish, for example, white spot disease. Status – Require validation and further research
Justification	The most common cause of mortalities of eggs and larvae of tilapia and catfish in hatcheries are fungal, parasitic and bacterial infections. The farmers in Kenya have applied the use of prophylactics in preventing diseases in the farms. The commonly used prophylactic treatment is the use of Common salt (*Sodium*

	chloride) and Potassium permanganate. These prophylactics have been used to prevent fungal and possible bacterial diseases.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Input suppliers, Model authenticated hatcheries, women and youth groups, County Fisheries Departments, Kenya Fisheries Service, Government, Research and Higher Learning Institutions
Approaches to be used in dissemination	Training workshops/seminars, mass media, print media, social media, Agricultural shows and exhibitions, farmer field schools and farmer-to-farmer extension approach.
Most effective approach	Model farmers and hatcheries, farmer to farmer trainings and practical demonstrations
Critical/essential factors for successful promotion	• Improved prophylactic health products and fish biosafety practices. • Effective health management is critical for sustainable intensification of the smallholder aquaculture.
Partners/stakeholders for scaling up	• Multipliers / Hatcheries to take up the improved breeds for multiplication and avail to farmers • Engagement of county governments to take up the technology and avail it to farmers for improved livelihoods—food and nutrition security, poverty alleviation and income generation.
C: Current situation and future scaling up	
Counties where TIMP has been promoted	Kirinyaga, Machakos, Makueni, Kisii
Counties where TIMP is to be upscaled	Kisumu, Kakamega, Busia, Siaya, Machakos, Nyandarua
Challenges in dissemination	Inadequate extension and community outreach programs within the Counties
Recommendations for addressing the challenges	• Allocation of more funds for continued research and dissemination to increase uptake of the technology. • Enhanced collaboration with other NARS, Higher Education Institutions for upscaling innovation
Lessons learned	The effect of the probiotic on the performance of the fish is to increase the growth performance and survival of the fish.
Social, environmental, policy and market conditions necessary	Reliable markets for improved fish breeds products and stable prices
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Not yet determined
Estimated returns	To be determined
Gender issues and concerns in development and dissemination	Both gender friendly and efficient for youth
Gender issues and concerns in adoption and scaling up	The technology easily be taken up by women and youth groups

Gender related opportunities	Sustainable business enterprises which act as a source of income and livelihood
VMG issues and concerns in development and dissemination	For the innovation to be adopted by the VMGs requires training and support.
VMG issues and concerns in adoption and scaling up	The uptake of the innovation by VMG is still low
VMG related opportunities	The VMG can establish aquaculture enterprises to act as a source of income and livelihood
E: Case studies/profiles of success stories	
Success stories	Mortality of the fish was low in all the treatments and the survival were all above 70%. Administering probiotic showed significantly higher survival in all treatments. Better growth and survival could be an indication of better health conditions in fish fed probiotic supplemented feeds. *Bacillus* spp. produces several peptide antibiotics, including subtilin and bacitracin which improves immunity of fish
Application guidelines for users	Determine the optimal doses of baker's yeast, supplementation in feed, which might be helpful for optimum dietary utilization for the fish.
F: Contacts	
Contacts	Ms Mary Opiyo Kenya Marine and Fisheries Research Institute KMFRI P.O. Box 451-10230, Sagana marybede@gmail.com
Lead organization and scientists	The project is being implemented by KMFRI Sagana Centre as the lead institution. The lead scientists are Dr Jonathan Munguti, Dr Kevin Obiero, Ms Mary Opiyo, Ms Domitila Kyule, Ms Cecilia Muthoni, Mr Jacob Abwao, Ms Jane Fonda, Elijah Kembenya and Robert Ondiba
Partner Organizations	• Karatina University • JKUAT • South Eastern Kenya University • Kenya Fisheries Service • National Aquaculture Research and Development Training Centre • County Governments.

5.2 Therapeutic treatments (Antibiotic application rates)

Technology name	**Therapeutic (Antimicrobials) use in aquaculture**
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem to be addressed	Diseases and parasites are major threats experienced in aquaculture in Kenya. Fish are prone to bacterial, viral, fungal and parasitic infections but their susceptibility is aggravated by compromised

	environmental conditions. Fish kills experienced in some cages within the lake has-been attributed to some bacterial (*Vibriosis*), parasitic and fungal infections (*Saprolegnia*spp.) coupled with regular upwelling. The effect of diseases in the cage system can be fatal due to the high stocking density that facilitates transmission and elevated stress on the fish, making them more vulnerable to disease causing agents.
What is it? (TIMP description)	Antimicrobials (AMs) are defined as pharmaceuticals that kill or inhibit the growth of microorganisms and include antibiotics (AB), antivirals, antifungals, and antiprotozoal substances. Recent increases in production have largely been achieved through intensification of existing farming systems, resulting in higher risks of disease outbreaks. Status – Require validation and further research
Justification	There is need for governments and international organizations to assist with disease-free juveniles and vaccines, enforce rigid monitoring of the quantity and quality of AMs used by farmers and the AM residues in the farmed species and in the environment, and promote measures to reduce potential human health risks associated with AM resistance.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, input suppliers, model authenticated hatcheries, Kenya Fisheries Service, Government, Research and Higher Learning Institutions
Approaches used in dissemination	Training workshops/seminars, and farmer-to-farmer extension approach.
Most effective approach	Model farmers and hatcheries, farmer to farmer trainings and practical demonstrations
Critical/essential factors for successful promotion	• Improved prophylactic health products and fish bio-safety practices. • Effective health management is critical for sustainable intensification of the smallholder aquaculture.
Partners/stakeholders for scaling up	Engagement of county governments to take up the innovations and avail application guidelines to farmers.
C: Current situation and future scaling up	
Counties where already promoted	Kakamega, Migori, Homa Bay, Meru, Nyeri, Kirinyaga, Siaya, Kisumu
Counties where TIMP is to be upscaled	Kakamega, Kisumu, Siaya, Busia
Challenges in dissemination	Inadequate extension and community outreach programs within the Counties
Recommendations for addressing the challenges	National and County governments to reduce AM use through farmer training, spatial planning, assistance with disease identification, and stricter regulations
Lessons learned	Probiotic increase the growth performance and survival of the fish.

Social, environmental, policy and market conditions necessary	Reliable markets for improved fish breeds products and stable prices
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Not yet determined
Estimated returns	To be determined
Gender issues and concerns in development and dissemination	Both gender friendly and efficient for youth
Gender issues and concerns in adoption and scaling up	The innovation easily be taken up by women and youth groups
Gender related opportunities	Sustainable aquaculture enterprises and high profit margins for farmers due to limited disease occurrences
VMG issues and concerns in development and dissemination	This innovation will require support for the Vulnerable and Marginalized Groups
VMG issues and concerns in adoption and scaling up	The uptake by VMG is still low
VMG related opportunities	The VMG can establish aquaculture enterprises to act as a source of income and livelihood
E: Case studies/profiles of success stories	
Success stories	From a set of identified key mechanisms for AM usage, six proximate factors are identified: vulnerability to bacterial disease, AM access, disease diagnostic capacity, antimicrobial resistance (AMR), target markets and food safety regulations, and certification.
Application guidelines for users	Research and academic institutions to assist with disease-free juveniles and vaccines, enforce rigid monitoring of the quantity and quality of AMs used by farmers and the AM residues in the farmed species and in the environment,
F: Contacts	
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Lead organization and scientists	The project is being implemented by KMFRI Sagana Centre as the lead institution. The lead scientists are Dr Jonathan Munguti, Dr Kevin Obiero, Ms Domitila Kyule, Ms Cecilia Muthoni, Mr Jacob Abwao, Ms Jane Fonda, Elijah Kembenya and Robert Ondiba
Partner Organizations	• Jomo Kenyatta University of Science and Technology (JKUAT) • Karatina University • South Eastern Kenya University • Kenya Fisheries Service • National Aquaculture Research and Development Training Centre • County Governments

5.3 Use of Probiotics

Technology name	Use of probiotics
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem to be addressed	Unpredictable weather patterns because of climate change leads to proliferation of disease vectors and pests. This brings about challenges of diseases in intensive aquaculture systems. Prophylactic products are novel low-cost alternatives that contribute to improved animal health and profitability of intensified smallholder operations.
What is it? (TIMP description)	Probiotics are feed supplements and immune-stimulants. Administration of probiotics and yeast containing glucans through immersion, dietary inclusion or injection has been found to enhance many types of immune responses, resistance to bacterial and viral infections and to environmental stress in many fish species. Status – Require validation and further research
Justification	To improve the overall nutrient utilization by fish and immunity of the fish, probiotics is important in low input systems having received much attention as a new strategy in fish feeding and health management. Preliminary results show probiotic increase the growth of fish reared in low input ponds. The following observations have been made: - 1.Baker's yeast (*Saccharomyces cerevisiae*) is recommended for use at 4g Kg^{-1} of feed 2.*Bacillus subtilis* supplementation level is recommended at 10 g Kg^{-1} of feed
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Input suppliers, Model authenticated hatcheries, women and youth groups, County Fisheries Departments, Kenya Fisheries Service, Government, Research and Higher Learning Institutions
Approaches used in dissemination	Training workshops/seminars, mass media, print media, social media, Agricultural shows and exhibitions, farmer field schools and farmer-to-farmer extension approach.
Most effective approach	Model farmers and hatcheries, farmer to farmer trainings and practical demonstrations
Critical/essential factors for successful promotion	• Improved prophylactic health products and fish biosafety practices. • Effective health management is critical for sustainable intensification of the smallholder aquaculture.
Partners/stakeholders for scaling up	• Multipliers / Hatcheries to take up the improved breeds for multiplication and avail to farmers • Engagement of county governments to take up the technology and avail it to farmers for improved livelihoods—food and nutrition security, poverty alleviation and income generation.

C: Current situation and future scaling up	
Counties where TIMP already promoted	Kirinyaga, Machakos, Makueni, Kisii
Counties for further upscaling	Kisumu, Siaya, Kakamega, Busia
Challenges in dissemination	Inadequate extension and community outreach programs within the Counties
Recommendations for addressing the challenges	• Allocation of more funds for continued research and dissemination to increase uptake of the technology. • Enhanced collaboration with other NARS, Higher Education Institutions for upscaling innovation
Lessons learned	The effect of the probiotic is to increase the growth performance and survival of the fish.
Social, environmental, policy and market conditions necessary	Reliable markets for improved fish breeds products and stable prices
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Not yet determined
Estimated returns	To be determined
Gender issues and concerns in development and dissemination	Both gender friendly and efficient for youth
Gender issues and concerns in adoption and scaling up	The technology easily be taken up by women and youth groups
Gender related opportunities	Youth and women can establish sustainable business enterprises which act as a source of income and livelihood
VMG issues and concerns in development and dissemination	This is a technology that can be easily carried out by Vulnerable and Marginalized Groups
VMG issues and concerns in adoption and scaling up	The uptake by VMG is still low
VMG related opportunities	The VMG can establish aquaculture enterprises to act as a source of income and livelihood
E: Case studies/profiles of success stories	
Success stories	Mortality of the fish was low in all the treatments and the survival were all above 70%. Administering probiotic showed significantly higher survival in all treatments. Better growth and survival could be an indication of better health conditions in fish fed probiotic supplemented feeds. *Bacillus* spp. produces several peptide antibiotics, including subtilin and bacitracin which improves immunity of fish
Application guidelines for users	Determine the optimal doses of baker's yeast, supplementation in feed, which might be helpful for optimum dietary utilization for the fish.
F: Contacts	
Contacts	Ms Mary Opiyo

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Lead organization and scientists	The project is being implemented by KMFRI Sagana Centre as the lead institution. The lead scientists are Dr Jonathan Munguti, Dr Kevin Obiero, Ms Mary Opiyo, Ms Domitila Kyule, Ms Cecilia Muthoni, Mr Jacob Abwao, Ms Jane Fonda, Elijah Kembenya and Robert Ondiba
Partner Organizations	• Karatina University • JKUAT • South Eastern Kenya University • Kenya Fisheries Service • National Aquaculture Research and Development Training Centre • County Governments.

5.4 Fish Biosecurity and Predator control practices

Technology name	**Fish Biosecurity and Predator control practices**
Category (i.e. technology, innovation or management practice)	Management Practices
A: Description of the technology, innovation or management practice	
Problem addressed	A predator is any living organism that hunts down live fish in culture systems for food. Fish predators can be birds, terrestrial animals, insects, other fish etc. Impact of predators in culture systems include mortalities, spread disease parasites and pests, transport algae from other water bodies to the pond, tank or hapa, wound fish and puncture liners in shallow ponds.
What is it? (TIMP description)	Bio-security refers to any step that would prevent entry of pathogens into farms or hatcheries, thereby reducing therisk of disease outbreaks and consequent AM use. On pond-based grow-out farms, simple bio-security measures would include deterrents to keep disease vectors out (such as bird nets and scares, or barriers for crabs), drying of sediments, limingof ponds, and organic waste removal before re-stocking. Status – Require validation and further research
Justification	Biosecurity policies and procedures should be followed to decrease the likelihood of health-related problems occurring.
Region promoted	Countrywide especially counties with high aquaculture potential e.g. Kakamega, Migori, Homa Bay, Meru, Nyeri, Kirinyaga, Siaya, Kisumu, Embu, Busia
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, input suppliers, model authenticated hatcheries, Kenya Fisheries Service, Government, Research and Higher Learning Institutions
Approaches used in dissemination	Training workshops/seminars, and farmer-to-farmer extension approach.

Most effective approach	Model farmers and hatcheries, farmer to farmer trainings and practical demonstrations
Critical/essential factors for successful promotion	Foot baths and vehicle dip at the main gate; vehicle spray; footbaths; Fenced farm, pond cover with predator nets, bird
	netting, screen on water inlet and outlets and designated are for waste disposal; tanks set aside for quarantine, screens on inlets, prophylactics salt solution and quarantine and protocols
Partners/stakeholders for scaling up	Model farmers and County governments to upscale innovations and apply guidelines to farmers.
C: Current situation and future scaling up	
Current extent of reach	Low
Challenges in dissemination	Lack of knowledge on fish bio-security due to inadequate extension and community outreach programs
Recommendations for addressing the challenges	Biosecurity policies and procedures should be followed to decrease the likelihoodof health-related problems occurring.
Lessons learned	The the probiotic increases the growth performance and survival of the fish.
Social, environmental, policy and market conditions necessary	Reliable markets for improved fish breeds products and stable prices
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Not yet determined
Estimated returns	To be determined
Gender issues and concerns in development and dissemination	Both gender friendly and efficient for youth
Gender issues and concerns in adoption and scaling up	The innovation easily be taken up by women and youth groups
Gender related opportunities	Sustainable aquaculture enterprises and high profit margins for farmers due to limited disease occurrences
VMG issues and concerns in development and dissemination	This innovation will require support for the Vulnerable and Marginalized Groups
VMG issues and concerns in adoption and scaling up	The uptake by VMG is still low
VMG related opportunities	The VMG can establish aquaculture enterprises to act as a source of income and livelihood
E: Case studies/profiles of success stories	
Success stories	Major hatcheries and aquaculture facilities in Kenya have taken the prerogative of establishing fish health monitoring and bio-security control procedures to minimize the risk of disease which often, ends up affecting nearby aquatic life if not well managed.
Application guidelines for users	Bio-security policies and procedures should be followed to decrease the likelihood of health-related problems occurring.
F: Contacts	

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	The lead scientists are Dr Jonathan Munguti, Dr Kevin Obiero, Ms Domitila Kyule, Ms Cecilia Muthoni, Mr Jacob Abwao, Ms Jane Fonda, Elijah Kembenya and Robert Ondiba
Partner Organizations	• Jomo Kenyatta University of Science and Technology (JKUAT) • Karatina University • South Eastern Kenya University • Kenya Fisheries Service • National Aquaculture Research and Development Training Centre • County Governments.

6.0` Post Harvest Loss Reduction and Value Addition

6.1 Fish Smoking Kiln

Technology name	**2. Fish smoking Kiln**
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	Traditional kilns had considerable disadvantages that included; low capacity, inefficient fuel usage (firewood) thereby contributing more to forest depletion. Moreover, the health hazard which its operation entails because of the smoke affects eyes and lungs of the operator. In addition, fingers were burnt due to undue exposure to direct heat, the procedure is very laborious.
What is it? (TIMP description)	The smoking kiln was designed and constructed based on materials availability. It is rectangular with dimension of 132cm height x 53cm breadth x 54cm width. It has an inner lining made of stainless-steel sheets. The stainless-steel sheet was lagged with fiber glass and covered with another coating of stainless steel. The double wall structure with the insulating material was provided to conserve the heat energy by reducing heat loss and to keep the working environment conducive for the user and to improve the overall performance of the kiln. The kiln has four six tray shelves made of stainless wire gauge and properly finished edge fine wire mesh which prevents the dried fish products from falling through and made in such a way to allow them to be pulled out without tipping and easily slide in and out. The drying capacity varies with species and thickness of

	fish. The kiln has a double wing door which can be opened and closed easily. The door fits smoothly when in a closed position. This helps to improve the air and heat circulation within the kiln chamber and removal of moisture out of the dried product. The kiln has been fitted with chimney at the top which serve as the exhaust for the moisture laden air. The kiln was powered with saw dust for smoking and charcoal for drying operations. Status – Ready for upscaling
Justification	Poor quality smoked fish prone to moulds due to ineffective fish smoking has been witnessed by the users. This necessitated the need
	to develop different models of improved ovens and kilns for effective and efficient utilization of the different fish species in our water bodies. This was to address challenges of the traditional kilns taking into account all factors and the disadvantages of traditional kiln and for improved performance
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Traders, women and youth groups, County Fisheries Departments, Kenya Fisheries Service, Government, Research and Higher Learning Institutions
Approaches used in dissemination	Individual visits to the fish outlets, practical demonstrations of technology, training workshops/seminars, mass media, print media, social media, documentaries, Agricultural shows and exhibitions, farmer field schools
Most effective approach	Model fish trading outlets, Trader to trader trainings and practical demonstrations
Critical/essential factors for successful promotion	□ Develop several smoking kilns to extent to all the counties in Kenya
Partners/stakeholders for scaling up	• Hoteliers/ Fish outlet for mass product development and production and avail them to distributors • Engagement of Key fish traders take up the technology and avail the products to consumers for improved livelihoods—food and nutrition security, poverty alleviation and income generation.
C: Current situation and future scaling up	
Current extent of reach	Kirinyaga, Makueni, Meru, Taita Taveta, Kiambu, Kakamega, Kisii, Kajiado, Nairobi, Embu and Thara Nithi Counties.
Counties TIMP to be upscaled	Kakamega, Busia, Siaya, Kisumu
Challenges in dissemination	Inadequate extension and community outreach programs
Recommendations for addressing the challenges	• There is need for intensified training for fish traders, hoteliers and extension to the county level for fast and meaningful impact; Improve KMFRI capacity to mass produce smoked fish products for local consumption and exportation; Allocation of more funds for continued research and dissemination to increase uptake of the technology. • Enhanced collaboration with other manufacturing for upscaling the technology and continued improvement of the formulations

Lessons learned	There is need for improved marketing through a target-oriented approach of existing customers and attracting new consumers for market penetration that will guide the aquaculture industry to improve production and profits.
Social, environmental, policy and market conditions necessary	Reliable markets for the fish products and stable prices
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	1) Smoked cat fish=200, 2) Smoked tilapia=300
Estimated returns	Varies according to product (Excel Table to be developed for cost calculations)
Gender issues and concerns in development and dissemination	This innovation dissemination process ensured 50% representation of women, youth and vulnerable groups in decision-making processes; and provision of targeted information, education, capacity building to all stakeholders regarding gender awareness as well as on HIV, nutrition and related social aspects.
Gender issues and concerns in adoption and scaling up	The innovation easily be taken up by women and youth groups
Gender related opportunities	Youth and women can establish sustainable business enterprises which act as a source of income and livelihood
VMG issues and concerns in development and dissemination	These are innovative products that can be easily carried out by Vulnerable and Marginalized Groups
VMG issues and concerns in adoption and scaling up	The uptake by VMG is still low
VMG related opportunities	The VMG can establish and undertake value addition to act as a source of income and livelihood
E: Case studies/profiles of success stories	
Success stories	Practical demonstration trainings were conducted in Machakos, Meru and Kisii Counties to build capacity of 50 fish farmers, traders, processors to promote uptake of fish smoking kiln.
Application guidelines for users	Need for training manuals and guidelines on product development.
F: Contacts	
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Lead organization and scientists	The project is being implemented by KMFRI Sagana Centre as the lead institution. The lead scientists are Dr. Jonathan Munguti, Dr Kevin Obiero, Ms Domitila Kyule, Ms Jane Fonda, Ms. Mary Opiyo, Mr Jacob Abwao
Partner Organizations	• Avil fish products outlet, Nyandarua County • Fish carnivore Centre, Meru • County Governments • Karatina University

6.2 Mama Karanga Box

Technology name	**"Mama Karanga Box"**
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem addressed	Mama Karanga are faced with daily structural and gender-based challenges. These challenges include the following: • Difficulty in access to fresh fish due to their total dependence on the fishermen and the competition from bigger traders; • Low representation and decision-making power inside the Beach Management Units (BMU)
	• Poor quality and low value processed products due to inappropriate equipment and lack of relevant skills • Household food insecurity due to low and uncertain income: 25.9% of women are head of families with an average of 7 dependents in the family.
What is it? (TIMP description)	Mama Karanga refers to female small-scale fishery actors: traditional fish mongers and processors, well-known for their characteristic fried fish sold in the street markets of coastal Kenya. Their fish is mostly used at household level. The improved fried fish display box comes with a solar lantern that runs for six hours on high setting and 15 hours on low setting and can be put out in the sun to charge during the day. The box has a capacity of 10 to 15 kgs of fish and is layered with aluminium instead of the newspapers that line traditional boxes. It is also well-ventilated and easy to clean thereby boosting food safety and hygiene.
Justification	The improved fish display box to protect fishmongers against carbon emissions from the commonly used "koroboi" kerosene lamps. The improved fried fish display box comes with a solar lantern that runs for six hours on high setting and 15 hours on low setting and can be put out in the sun to charge during the day. The intervention is aimed at spreading food safety practices to reduce Post-Harvest Losses (PHL) in small scale fisheries; to improve raw and processed sea food quality and its added value and, to diversify the final products sold into local markets.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Fish Traders, Women and youth groups
Approaches used in dissemination	Agricultural trade shows, practical training workshops/seminars, mass media, print media, social media, documentaries, Agricultural shows and exhibitions, farmer field schools
Most effective approach	Model fish trading outlets, Trader to trader trainings and practical demonstrations

Critical/essential factors for successful promotion	Develop several smoking kilns to extent to all the counties in Kenya
Partners/stakeholders for scaling up	• Hoteliers/ Fish outlet for mass product development and production and avail them to distributors • Engagement of key fish traders take up the technology and avail the products to consumers for improved livelihoods—food and nutrition security, poverty alleviation and income generation.
C: Current situation and future scaling up	
Current extent of reach	Kilifi and Kwale County but technology can be upscaled nationally
Counties where TIMP to be upscaled	Busia, Kisumu, Siaya, Kakamega
Challenges in dissemination	Inadequate extension and community outreach programs within the Counties
Suggestions for addressing the challenges	There is need for intensified training for fish traders, hoteliers and extension to the county level for fast and meaningful impact.
	• Improve KMFRI capacity to mass produce smoked fish products for local consumption and exportation • Allocation of more funds for continued research and dissemination to increase uptake of the technology. • Enhanced collaboration with other manufacturing for upscaling the technology and continued improvement of the formulations
Lessons learned	When women sell their fish by the roadside in the evening, with illumination from korobois (traditional kerosene lamps), they inhale a lot of black carbon. Each Mama Karanga uses a quarter to half a litre of paraffin every night, which emits 2.53 kilogrammes of carbon dioxide. In Mombasa alone, that accounts for more than 574,000 kilogrammes of carbon dioxide per year. Kerosene lamps emit 20 times more black soot than other lamps, and that black carbon lingers in the atmosphere for about two weeks, spelling doom for human health and the environment. Therefore, Kenyans should be encouraged to use clean technologies to protect the climate.
Social, environmental, policy and market conditions necessary	Reliable markets for the fish products and stable prices
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	The big box goes for KShs15,000, while the small one is sold for Sh12,000.
Estimated returns	To be determined from economic baseline studies
Gender issues and concerns in development and dissemination	This innovation dissemination process ensured 50% representation of women, youth and vulnerable groups in decision-making processes; and provision of targeted information, education, capacity building to all stakeholders regarding gender awareness as well as on HIV, nutrition and related social aspects.
Gender issues and concerns in adoption and scaling up	The innovation easily be taken up by women and youth groups

Gender related opportunities	The improved box presents great business opportunities for Kenyans to use clean technologies to protect the climate
VMG issues and concerns in development and dissemination	These are innovative products that can be easily carried out by Vulnerable and Marginalized Groups
VMG issues and concerns in adoption and scaling up	The uptake by VMG has very high potential.
VMG related opportunities	The VMG can establish and undertake value addition to act as a source of income and livelihood
E: Case studies/profiles of success stories	
Success stories	Some 45 fishmongers were given the improved fish display boxes in Mombasa. Other counties also want to roll it out to their fishmongers, with Kilifi having bought 160 pieces and Kwale 45 boxes.
Application guidelines for users	Need for training manuals and guidelines on product development.
F: Contacts	
Contacts	Dr Peter Michael Oduor-Odote Kenya Marine and Fisheries Research Institute Business Development Manager/Research Scientist P.O Box 81651-80100 Mombasa, Kenya podote@gmail.com
Lead organization and scientists	The project is being implemented by KMFRI Mombasa Centre as the lead institution. The lead scientists are Ms Domitila Kyule, Ms Jane Fonda, Ms.Cecilia Muthoni
Partner Organizations	• Lamu, Kilifi and Kwale Counties • Karatina University • Fish Outlets

6.3 Value added fish products

Technology name	**KMFRI value added fish products**
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	Micronutrient deficiencies affect hundreds of millions, particularly women and children in Kenya leading to increased risks of prenatal and maternal mortality, growth retardation, child mortality, cognitive deficits and reduced immune function have been reported. This necessitates, the need to develop superior farmed fish products niche through the development of value addition innovations for aquaculture products that meet consumer preferences and needs. Moreover, value addition addresses the issue of post-harvest losses in fish, increased incomes hence improved livelihoods to communities

What is it? (TIMP description)	The 12 diversified fish products include; 1) Fish samosas, 2) Fish sausages, 3) Fish burgers, 4) Fish pies, 5) Fish skewers, 6) Fish balls, 7) Fish soup, 8) Smoked cat fish, 9) Smoked tilapia, 10) Fish fingers, 11) Dried tilapia, and 12) Fish oil. They are superior products that are highly nutritive and easy to prepare. The various recipes have been described and packaged in a fish recipe book. Four of the products have been certified by Kenya Bureaus of Standards (KEBS). Status – Ready for upscaling
Justification	Demand for fish and fish products is increasing rapidly in Kenya driven by population and income growth, increased awareness of the health benefits of fish consumption and changes in lifestyles and consumer preferences. As aquaculture in Kenya sustains its steady growth trend, a support mechanism with attractive, favourable and profitable marketing enterprises is crucial. To that end, the development of superior farmed fish products niche is unavoidable. The establishment of value addition technologies for aquaculture products that satisfy consumes needs and preferences make this possible. To increase aquaculture products market value, expand
	consumer preference and longer shelf life, aquaculture value chain actors at different chain nodes are both adopting and adapting various technologies, those of which have become fundamental in improving food safety and strengthening the country's food security.
Region promoted	Kirinyaga, Makueni, Meru, Taita taveta, Kiambu, Kakamega, Kisii, Kajiado, Nairobi, Embu and Thara Nithi Counties.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Traders, women and youth groups, County Fisheries Departments, Kenya Fisheries Service, Government, Research and Higher Learning Institutions
Approaches used in dissemination	Individual visits to the fish outlets, practical demonstrations of technology, training workshops/seminars, mass media, print media, social media, documentaries, Agricultural shows and exhibitions, farmer field schools
Most effective approach	Model fish trading outlets, Trader to trader trainings and practical demonstrations
Critical/essential factors for successful promotion	Develop a decentralized fish processing factory and outlets
Partners/stakeholders for scaling up	• Hoteliers/ Fish outlet for mass product development and production and avail them to distributors • Engagement of Key fish traders take up the technology and avail the products to consumers for improved livelihoods—food and nutrition security, poverty alleviation and income generation.
C: Current situation and future scaling up	
Current extent of reach	Moderate (medium)
Challenges in dissemination	Inadequate extension and community outreach programs within the Counties

Recommendations for addressing the challenges	• There is need for intensified training for fish traders, hoteliers and extension to the county level for fast and meaningful impact. • Encourage farmers to mass produce commercial fish products for local consumption • Allocation of more funds for continued research and dissemination to increase uptake of the technology. • Enhanced collaboration with other manufacturing for upscaling the technology and continued improvement of the formulations
Lessons learned	There is need for improved marketing through a target-oriented approach of existing customers and attracting new consumers for market penetration that will guide the aquaculture industry to improve production and profits.
Social, environmental, policy and market conditions necessary	Reliable markets for the fish products and stable prices
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	1) Fish samosas=40, 2) Fish sausages=30, 3) Fish burgers=200, 4) Fish pies= 5) Fish skewers=50, (6) Fish balls=30, (7) Smoked catfish=200, 8) Fish fingers=30
Estimated returns	Varies according to product (Excel Table to be developed for cost calculations)
Gender issues and concerns in development and dissemination	This innovation dissemination process ensured 50% representation of women, youth and vulnerable groups in decision-making processes; and provision of targeted information, education, capacity building to all stakeholders regarding gender awareness as well as on HIV, nutrition and related social aspects.
Gender issues and concerns in adoption and scaling up	The innovation easily be taken up by women and youth groups
Gender related opportunities	Youth and women can establish sustainable business enterprises which act as a source of income and livelihood
VMG issues and concerns in development and dissemination	These are innovative products that can be easily carried out by Vulnerable and Marginalized Groups
VMG issues and concerns in adoption and scaling up	The uptake by VMG is still low
VMG related opportunities	The VMG can establish and undertake value addition to act as a source of income and livelihood
E: Case studies/profiles of success stories	
Success stories	Six outlets have been established in Meru, Kirinyaga, Nyandarua, Kiambu, Embu and Nakuru counties. A fish recipe book published. Traders who adopted this technology have had sustained sources of income and livelihood
Application guidelines for users	Need for training manuals and guidelines on product development.
F: Contacts	
Contacts	Ms Domitila N. Kyule Kenya Marine and Fisheries Research Institute KMFRI

	P.O. Box 451-10230, Sagana domsjos2016@gmail.com
Lead organization and scientists	The project is being implemented by KMFRI Sagana Centre as the lead institution. The lead scientists are Dr Jonathan Munguti, Dr Kevin Obiero, Ms Domitila Kyule, Ms Jane Fonda, Ms Mary Opiyo, Mr Jacob Abwao
Partner Organizations	• Avil fish products outlet, Nyandarua County • Fish Carnivore Centre, Meru • County Governments • Karatina University

6.4 Nutrition value added products e.g. Fish powders for infants "Boneless fish supplements

Technology name	**Nutrition based value added products e.g. Fish powders for infants "Boneless fish supplements**
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem to be addressed	Small fish available locally in many farms Small fish available locally in the rice fields and channels is optimal, especially when the head and bones are included, for child growth and development.
	Small Fish Powder is an affordable, local solution that can help to increase access to animal source food year round.
What is it? (TIMP description)	The small sized fish which in most cases are not very marketable but are produced in large scale can be dried, crushed into powder and made available. Fish Powder is high in protein and contains many essential micronutrients even after four months of storage
Justification	The Kenya Demographic Health Survey conducted in 2014 reflected an underweight rate of 16.9 per cent among children who do not get balanced diets during the first 100 days, which leads to cognitive and physical damage. Findings show that chances of such children recovering decreased after they reached two years. In Kilifi for example, one out three children are underweight and stunted due to chronic nutritional deficiency. Stunting is being severely short for one's age and is an irreversible consequence of poor maternal diet, poor hygiene and sanitation practices and an inadequate diet during the first two years of a child's life. Stunting undermines children's health through increased illness. It also impacts children's educational achievement by limiting cognitive development and years of schooling, and reduces lifetime earnings. Therefore there is a need to come up with powdered fish to be used in children nutrition.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Middle men who get the fish from farmers Human nutritionists
Approaches to be used in dissemination	Practical demonstrations of the innovations, training workshops/seminars

Critical/essential factors for successful promotion	• Mass production of fingerlings and juvenile fish • Knowledge on processing, shelf life • Detailed administration procedures to ensure the powder blends well with the food the children eat • Best Management Aquaculture Practices when producing and processing the fish
Partners/stakeholders for scaling up and their roles	• County infant health officers who will avail this information to lactating mothers. • Engagement of county governments to take up the information and avail it to farmers for improved livelihoods—food and nutrition security, poverty alleviation and income generation.
C: Current situation and future scaling up	
Counties where already promoted. (if any)	Homa Bay, Kilifi, Kirinyaga, Kisii, Kitui, Laikipia, Machakos, Makueni, Meru, Nakuru, Nyeri, Muranga
Counties where TIMPs will be upscaled	Busia, Kakamega, Siaya, Lamu, Kisumu, Nyandarua (as prioritized by the target counties)
Challenges in dissemination	Inadequate knowledge on the fish processing harvesting techniques
Suggestions for addressing the challenges	• There is need for intensified training/workshop • Allocation of more funds for continued research and dissemination this innovation • Enhanced collaboration with other NARS, Higher Education Institutions for upscaling the innovation
Lessons learned in upscaling (if any)	Decreased cases of malnutrition among children in Kilifi county Children willingness to take food that is blended with boneless fish powder can never be disputed
Social, environmental, policy and market conditions necessary for development and upscaling	Reliable markets and stable prices
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES. 120/- per kilogram of fish powder
Estimated returns	Varies according production system (Excel Table to be developed for cost calculations)
Gender issues and concerns in development and dissemination	This innovation dissemination process ensured 50% representation of women, youth and vulnerable groups in decision-making processes; and provision of targeted information, education, capacity building to all stakeholders regarding gender awareness as well as on HIV, nutrition and related social aspects.
Gender issues and concerns in adoption and scaling up	The innovation can easily be taken up by women and youth groups
Gender related opportunities	Youth and women can establish sustainable aquaculture business enterprises which act as a source of income and livelihood
VMG issues and concerns in development and dissemination	This is a innovation that can be easily carried out by Vulnerable and Marginalized Groups

VMG issues and concerns in adoption and scaling up	The uptake by VMG is still low
VMG related opportunities	The VMG can establish aquaculture enterprises to generate income and livelihood
E: Case studies/profiles of success stories	
Success stories	The best performance of fish powder was conducted in Kilifi county and documented
Application guidelines for users	There is need for training manuals, booklet and guidelines fish powder recipes and processing
F: Status of TIMP readiness	Ready for upscaling
G: Contacts	
Contacts	Dr. Jonathan Munguti Kenya Marine and Fisheries Research Institute KMFRI P.O. Box 451-10230, Sagana kmfrinardtc@gmail.com
Lead organization and scientists	The project is being implemented by KMFRI Sagana Centre as the lead institution. The lead scientists are Dr Jonathan Munguti, Dr Kevin Obiero, Josiah Ani, Ms Mary Opiyo, Ms Domitila Kyule, Cecilia Muthoni, Mr Jacob Abwao, Jane Fonda, Elijah Kembenya and Robert Ondiba
Partner Organizations	• University of Eldoret • South Eastern Kenya University • Kenya Fisheries Service • National Aquaculture Research and Development Training Centre • County Governments

7.0 Marketing and Distribution Channels

7.1 Aquaculture Market Information Platform

Technology name	**Aquaculture Market Information Platform (AMIP)**
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	Typically, farmers are faced with information gaps at all stages of the production cycle; supply of inputs, harvesting, storage, transportation and marketing.
What is it? (TIMP description)	The Aquaculture Market Information Platform (AMIP) is an online platform aimed at linking up aquaculture stakeholders to mitigate marketing constraints. Through AMIP famers can log in and find out the prices for their commodities and where there is demand for fish. AMIP is hosted by KMFRI-NARDTC and is available as a webbased service.

Justification	The anticipated increase in fish production needed increased marketing strategy and avenues. KMFRI decided to create a platform for famers to access markets for their products. This resulted to the establishment of aquaculture market information platform to provide famers with information on available outlets for farmed fish (AMIP). Through AMIP famers could log in and find out the prices for their commodities and where there was demand for fish. KMFRI solicited for a consultant to develop AMIP Platform which was intended to provide a geo-referenced database of most actors in the aquaculture sector
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Input suppliers, Model authenticated hatcheries, women and youth groups, County Fisheries Departments, Kenya Fisheries Service, Government, Research and Higher Learning Institutions
Approaches used in dissemination	Individual farm visits, practical demonstrations of technology, training workshops/seminars, mass media, print media, social media, Agricultural shows and exhibitions, farmer field schools and farmerto-farmer extension approach.
Critical/essential factors for successful promotion	Willingness of users to embrace the new technology
Partners/stakeholders for scaling up	KARLO, KMD, NDMA, KFS, Ministry of Agriculture, Livestock, Fisheries, and Irrigation
C: Current situation and future scaling up	
Counties where TIMP already promoted	Kirinyaga, Meru, Taita Taveta and Kisii
Counties where TIMP to be upscaled	Kakamega, Kisumu, Lamu, Siaya, Nyandarua, Machakos
Challenges in dissemination	Mapping out all aquaculture service and input providers in the country
Recommendations for addressing the challenges	There is need for mapping all aquaculture service and input providers in the country
Lessons learned	AMIP supports; • A directory containing production details of fish farmers, feed producers, authenticated hatcheries and fish market outlets; • Robust geographically referenced user-friendly database of aquaculture stakeholders; • A user-friendly online market place to connect stakeholders to conduct business transactions • A resource centre containing accurate and timely aquaculture information in the entire fish value chain. • Mobile based platform to share and disseminate information to fish famers.
Social, environmental, policy and market conditions necessary	Willingness of stakeholders to embrace new technology

F: Contacts	
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Lead organization and scientists	The project will be implemented by KMFRI Sagana Centre as the lead institution. The lead scientists will be Dr. Jonathan Munguti, Dr Kevin Obiero, Ms Domitila Kyule, Ms Fonda Jane Awuor, Ms. Mary Opiyo, Ms Cecilia Muthoni, Mr Elijah Kembenya and Mr. Jacob Abwao

7.2 Enhanced Fish Market Information System (EFMIS)

Technology name	Enhanced Fish Market Information Platform (EFMIS)
Category (i.e. technology, innovation or management practice)	Information
A: Description of the technology, innovation or management practice	
Problem to be addressed	Users in the AVC who are not aware of service and input providers will be able to discover the entities in their local areas with ease. The directory will be a comprehensive platform that will enable users to instantly identify, learn about, and contact enterprises relevant to them.
What is it? (TIMP description)	EFMIS is an ICT pilot project based on mobile phones. It is a system for generating, packaging and disseminating essential market information from fish landing sites around the lakes and marine sources and markets in major urban areas across the participating counties and countries.
Justification	Running various entities in the AVC whether small startups or wellestablished entities requires the investors not only to be dedicated
	but to also make intelligent business decisions, often on a budget. Taking advantage of the directory which is inexpensive, is important.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Input suppliers, Model authenticated hatcheries, women and youth groups, County Fisheries Departments, Kenya Fisheries Service, Government, Research and Higher Learning Institutions
Approaches used in dissemination	Individual farm visits, practical demonstrations of technology, training workshops/seminars, mass media, print media, social media, Agricultural shows and exhibitions, farmer field schools and farmerto-farmer extension approach.
Critical/essential factors for successful promotion	Willingness of users to embrace the new technology

Partners/stakeholders for scaling up	KARLO, KMFRI, KFS,
C: Current situation and future scaling up	
Current extent of reach	Not implemented
Challenges in dissemination	Mapping out all aquaculture service and input providers in the country
Recommendations for addressing the challenges	There is need for mapping all aquaculture service and input providers in the country
Lessons learned	
Social, environmental, policy and market conditions necessary	Willingness of stakeholders to embrace new technology
F: Contacts	
Contacts	Dr. Jonathan Munguti Kenya Marine and Fisheries Research Institute P.O. Box 451 Sagana, KENYA Telephone: +254 7194045590 Website: http://www.kmfri.co.ke
Lead organization and scientists	The project will be implemented by KMFRI Sagana Centre as the lead institution. The lead scientists will be Dr. Jonathan Munguti, Dr Kevin Obiero, Ms Domitila Kyule, Ms Fonda Jane Awuor, Ms. Mary Opiyo and Mr. Jacob Abwao

7.3 Online aquaculture service and input directory

Technology name	**Online aquaculture service and input provider directory**
Category (i.e. technology, innovation or management practice)	Information
A: Description of the technology, innovation or management practice	
Problem to be addressed	Users in the AVC who are not aware of service and input providers will be able to discover the entities in their local areas with ease. The directory will be a comprehensive platform that will enable users to
	instantly identify, learn about, and contact enterprises relevant to them.
What is it? (TIMP description)	This directory will provide information about aquaculture entities (enterprise name), Contact & Physical Address, County, and Input/Service offered by the entity. The directory will list companies providing Fish Fry Fingerling and Brood stock, Feeds Input & Service Supplies, Cottage feed Industry, Aquaculture Equipment, Institutions offering Training, Research and extension services as well as Fish Processors and Traders. The directory will be a platform for all stake holders across the aquaculture value chain (AVC) as well as other actors and other

	decision-makers who want to expand and or improve aquaculture in the country.
Justification	Running various entities in the AVC whether small startups or wellestablished entities requires the investors not only to be dedicated but to also make intelligent business decisions, often on a budget. Taking advantage of the directory which is inexpensive is important.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Input suppliers, Model authenticated hatcheries, women and youth groups, County Fisheries Departments, Kenya Fisheries Service, Government, Research and Higher Learning Institutions
Approaches used in dissemination	Individual farm visits, practical demonstrations of technology, training workshops/seminars, mass media, print media, social media, Agricultural shows and exhibitions, farmer field schools and farmerto-farmer extension approach.
Critical/essential factors for successful promotion	Willingness of users to embrace the new technology
Partners/stakeholders for scaling up	KARLO, KMFRI
C: Current situation and future scaling up	
Current extent of reach	Not implemented
Challenges in dissemination	Mapping out all aquaculture service and input providers in the country
Recommendations for addressing the challenges	There is need for mapping all aquaculture service and input providers in the country
Lessons learned	
Social, environmental, policy and market conditions necessary	Willingness of stakeholders to embrace new technology
F: Contacts	
Contacts	Dr. Jonathan Munguti Kenya Marine and Fisheries Research Institute P.O. Box 451 Sagana, KENYA Telephone: +254 7194045590 Website: http://www.kmfri.co.ke
Lead organization and scientists	The project will be implemented by KMFRI Sagana Centre as the lead institution.
	The lead scientists will be Dr. Jonathan Munguti, Dr Kevin Obiero, Ms Domitila Kyule, Ms Fonda Jane Awuor, Ms. Mary Opiyo and Mr. Jacob Abwao