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Poverty-Environment Action
for Sustainable Development Goals

Developing A Climate Smart Aquaculture Toolkit

A Synthesis Report

For Policymakers and Investors

ABBREVIATIONS AND ACRONYMS

CASA	Commercial Aquaculture for Smallholder and Agribusiness
CBD	Convention on Biodiversity
CCRF	Code of Conduct for Responsible Fisheries
CSA	Climate Smart Aquaculture
EAA	Ecosystem Approach to Aquaculture
EBA	Ecosystem-Based Approach
FAO	Food and Agriculture Organization
GHGs	Greenhouse Gases
GoM	Government of Malawi
IAS	Invasive Alien Species
IPPC	International Plant Protection Convention
LUANAR	Lilongwe University of Agriculture and Natural Resources
MALDECO	Malawi Development Corporation
NAC	National Aquaculture Centre
NAPA	National Adaptation Plan of Action
NAPA	National Adaptation Plan of action
NFAP	National Fisheries and Aquaculture Policy
NGOs	Non-Governmental Organization
NISSAP	National Invasive Alien Species Strategy and Action Plan
NSO	National Statistics Office
OIE	Office of International des Epizooties
SADC	Southern Africa Development Community
SDGs	Sustainable Development Goals
SHFs	Smallholder Farmers
SMEs	Small and medium-sized Enterprises
UNCCD	United Nations Convention on Combating Desertification
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
PPCR	Pilot Program for Climate Resilience
NCCMP	National Climate Change Management Policy

FOREWORD

The 2030 Agenda sets aims for the contribution and conduct of fisheries and aquaculture towards food security and nutrition, and the sector's use of natural resources, in a way that ensures sustainable development in economic, social and environmental terms, within the context of the FAO Code of Conduct for Responsible Fisheries. The national interest to develop the aquaculture subsector is growing for all good reasons – providing essential nutrition, supporting livelihoods and contributing to national development.

Malawi's aquaculture is dominated by smallholder farmers who are largely non-market oriented, facing numerous challenges that have led to low production stock volumes and minimal productivity resulting in inferior economic returns. Poor quality feed and fingerlings, limited access to financing opportunities, low interest among investors, climate change impacts, and environmental externalities, all call for strategic transformation of the aquaculture sector. The transformation is needed to satisfy the growing demand for quality animal proteins in the country and contribute to poverty reduction among the most vulnerable groups in the society women and children being the key targets. On the other, the risks associated with aquaculture production and the fragmentation of the sector – especially among smallholder farmers – have limited the appetite for investors to finance the sector. While many Climate smart Aquaculture opportunities already have sound underlying profitability, more efforts to promote good practices are needed for mitigation and adaptation in compliance with Malawi's Intended National Determined Contribution (INDC); the Climate Change Management Policy; and the associated Climate Change Investment Plan, and other international obligations the country shoulders.

Policymakers are better placed to address market and regulatory failures to create the right enabling conditions towards the transition to climate smart aquaculture. This synthesis report primarily informs the development of Climate Smart Aquaculture toolkit which will guide future investment in, or financing of, aquaculture development for increased adaptation, mitigation and increased productivity and incomes for poverty reduction. The aim is to support building resilience of smallholder farmers and investors from the impacts of climate change which will not only lead to accelerated growth but also sustainable growth of the sector. The report provides a summary of the aquaculture sector and its potential for investment, a description of the climate change risks and mitigation and adaptation strategies, and a presentation of possible financial arrangements the country can consider supporting SMEs.

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EXECUTIVE SUMMARY

Malawi's aquaculture is dominated by smallholder farmers with little market orientation yet, facing numerous challenges leading to low production of stock volumes and minimal productivity bringing unattractive economic returns. Climate Smart aquaculture (CSA) endeavours to achieve three development goals – (i) increasing productivity of the aquaculture farming systems to increase incomes (ii) reducing of greenhouse gas emissions (mitigation) and (iii) adaptation for resilience from climate change. These triple goals link countries' development outcomes such as improved nutrition and food security, and poverty reduction. Commercial Aquaculture for Smallholder and Agribusiness (CASA) for Malawi envisions huge investment into the sector to stimulate Malawi's economic growth and poverty reduction. CASA is strategically relevant to the current policy dilemmas in the sector, but questions on the sector's potential contribution to greenhouse gas (GHG) emissions, the benefit of the most vulnerable, especially women, and the sector's vulnerability and the need for adaptation to climate change call for attention.

This synthesis report is one of the deliverables stipulated in the Terms of Reference on the assignment: Development of Climate Smart Aquaculture Toolkit. The report is prepared for policymakers, potential and operating investors in the aquaculture industry in order to stimulate their interest to take part in the aquaculture sector transformation for poverty reduction through climate smart aquaculture as a model of development. Methodologically, the synthesis integrates literature and stakeholder consultations. Consultations were held with national and district level personnel, smallholder farmers and the private sector.

The solution to aquaculture's challenges rest in commitment to the transformation of the sector to embrace a more holistic approach to the[its?] development. The recent CASA (2020) strategic report for Malawi identified numerous problems, at all stages of the value chain, that impede participation of actors in the market system, particularly small-scale players. Priority areas included (i) low production volumes below market demand (ii) use of low-quality inputs by small-scale producers (iii) Lack of product aggregation arrangements to support viable investment in value addition through processing, distribution and marketing (iv) lack of knowledge and skills in fish processing for value addition (v) limited access to finance for investment in downstream functions of the value chains.

Overall, low production volumes are a result of several factors including the small number of large investors and the small number of local fish farmers although increased trends are emerging. At the farm level, climate change negatively affects production and emerges in form of increased temperatures, decreased water availability, decreased and increased rainfall, drought, flooding, storms and flash floods. In years of below average rainfall, fish farming productivity is negatively affected due to low water levels forcing famers to harvest the stock before time. Similarly, extreme cold conditions negatively affect fingerling production and fish growth in general. The Chambo Farm Limited, in 2015, had the worst experience of extreme cold weather conditions which affected fish growth and fingerling production. These impacts have reduced farmers' economic returns as demonstrated by two case studies in this report.

There are many adaptation practices SHFs are employing in production, but insufficient to overcome the magnitude of recent climatic changes and extreme events. Observed measures include (i) deep pond construction to retain more water for longer periods before the next onset of rainfall (ii) early harvesting of the stock before the water diminishes (iii) sexual segregation for fast growth. The CASA report suggests

that Cage farming technology involving the installation of cages – probably in Lake Malawi – would be a more effective adaptation to low average rainfall as well as flood but require thorough prior assessments to identify the potential environmental impacts of possible changes in water quality parameters. In some parts of the country such as Chikwawa and Nsanje floods destroy fish farms. Extreme events are therefore some of the constraints to increased productivity of the aquaculture sector.

Degradation of the watershed is increasing, because as climate changes, there is emerging competition for uses of the watershed. Crop farming is expanding into riverbanks for winter cropping and grazing livestock using the same watershed areas. Eventually, vegetation cover is reduced which impacts infiltration which affects the water table. These observations entail that, reduction of vulnerability of the aquaculture sector will require broader adaptation measures beyond the aquaculture sector and there is a strong need to integrate aquaculture management and adaptation into the watershed and/or lakeshore management.

Some farmers are adapting to the impacts of climate change, although many adaptation measures operate on a small spatial scale. For example, well-designed and well-built ponds with banana fields have helped farmers control adverse effects of floods and prevent loss of fish stocks. Deeper ponds, for example, provide a thermal refuge and greater DO reserves for fish, while raised pond embankments have helped prevent fish escapes and dyke destruction during floods and serve as water storage during droughts. Thus, well-conceived facility sustains multiple purposes besides aquaculture. Some farmers face the challenge of predators. One farmer introduced an aquatic weed to conceal fish from predators. Unfortunately, the weed is invasive creating yet another management problem. This maladaptation is a threat to aquaculture.

Limited access to quality feed and fingerlings, especially among smallholder farmers remains one of the key factors impacting productivity besides that the local commonly feed used has the potential to increase greenhouse gas (GHG) emissions. Some farmers are using maize bran, a large proportion of which sinks and decomposes. The system employed by the Mzuzu of using feeding pens reduces wastage thereby increasing the efficacy of feeding. This practice eventually reduces the potential GHG emissions.

Diversification for fast growing species such as the mirror carp has been throttled by the current policy of banning the introduction of exotic species although in some cases the policy has been flouted. Fast growing species would provide farmers the opportunity to increase production although caution is necessary to protect local biodiversity. Measure to reduce aquaculture vulnerability to the impacts of climate change should remain aligned to the national and international regulatory frameworks. The basic principle is to follow the ecosystem approach to aquaculture including (i) improved management of farms and choice of farmed species; (ii) improved spatial planning of farms that takes climate-related risks and compatibility with other land uses within the watershed; (iii) improved local, coordination of prevention and mitigation actions. (iv) capacity building is necessary to address vulnerability and improve adaptation to climate change, especially among smallholder fish farmers. An investment in capacity building especially in fish business is an investment that more than pays for itself.

Fish processing remains traditional with little or no value addition involving sun-drying, smoking, parboiling and pan-roasting are common. After harvesting, the fish are transported to market in one of three conditions: live, on ice or processed. In rare cases, fish is frozen and delivered to supermarkets. There is very little value adding in the fishing industry as of now although some farmers expressed innovative ideas of producing sausages from fish but lack the necessary financial and technical support. From the CSA perspective, fish smoking and other processing techniques contribute to problems of deforestation in areas surrounding those villages where such activities are carried out. In turn, deforestation renders the watershed more vulnerable to extreme weather events such as drought and

floods.

The CASA report further identified lack of product aggregation arrangements to support viable investment in downstream functions as one of the barriers to value addition in the sector. The driving factors include: (i) Weak market signals to provide incentives to agribusinesses to invest in downstream functions of the value chain and low production volumes that are sparsely located (ii) lack of knowledge and skills in basic processing of fish for value addition by SHFs (iii) limited access to finance for investment downstream in the value chain (iv) low fish supply to support downstream investment.

CSA is a relevant model to addressing current barriers to increasing productivity by promoting adaptation to the impacts of climate change, food security and mitigation at different scale of the value chain. CSA is a pragmatic approach to protecting the environment through adequate market pricing for natural resources through commercialization. The development of a CSA toolkit will need alignment with CASA's strategy to demonstrate not only[1] the environmental and social sustainability of CSA but the commercial viability of small and medium-sized (SME) agribusinesses with significant smallholder supply chains and attract more investment into these businesses. CASA is an important initiative from which the toolkit will provide a building block for sustainability. CASA has emphatically recognized that, at the production level, commercialisation is being held back because of very weak access to quality inputs. This is consequential for a sector that is significantly inputs driven and results in low profitability. FAO (2010) recognizes that Climate Smart Aquaculture emphasize on the role of markets and trade that may help buffer the impact of changes in production that affect food security, consumer prices and supply-demand gaps. However, the implications of climate change impacts and climate change policies on the entire supply and value chain need to be better understood. CASA acknowledged that it is ordinarily concerned with output markets and that it is necessary for the aquaculture sector to integrate support for potential feed manufacturers to prepare for and access investment in local feed production.

The opportunity to transform the sector through CSA is inherently immense but needs capacity for adoption and upscaling. First, the Ecosystem Approach to Aquaculture (EAA) outlines principles and practices that are central to ensuring the sustainability of the sector. However, the adoption of such principles and approaches is not keeping pace with the increasing need for their implementation. While there are traditional adaptation practices, their adoption too is limited by the lack of tools to upscale them for wider and long-term impact. In addition, those responsible for extension delivery are not adequately equipped in knowledge and practice to deal with climate change adaptation and mitigation. The aquaculture industry in Malawi faces is faced with weak extension support for smallholder fishers due to low numbers of qualified government extension workers. Productivity for most smallholder farmers is low, averaging about 1 metric tonne per hectare compared to a potential of 6 tonnes per hectare. This ultimately inhibits the profitability of the sector and holds back commercialisation. Adoption of Climate Smart Aquaculture needs to be supported by demonstrating its potential for profitability to contribute to household incomes. The toolkit will provide a technical guide besides case studies to demonstrate this potential for attraction of investors and vulnerable communities.

1 The CASA programme makes the commercial and development case for investing in agribusinesses that source produce from smallholders. It does this by demonstrating how this can be done effectively, by bridging evidence gaps and by ensuring investors and policymakers have access to the right information and people to make inclusive agribusiness models succeed. By showcasing successful models for businesses that source produce from smallholders and pulling together the evidence base supporting the commercial and development impact of their business models, CASA will attract more investment into the sector, boosting economic growth and raising demand for smallholder produce but the toolkit focuses on the striking balance between environmental, economic and social sustainability.

Recommendations 1.1: If the aquaculture sector in Malawi is to adapt through diversification by way of introduction of alien fish species, national policies and the following principles should be complied to[2].

Recommendation 1.2: The aquaculture sector must respond to the coupled challenges of climate change and environmental degradation while at the same time taking an active role in reducing its own impacts on the environment. The Ecosystem-Based Approach which accounts for broader scale environmental issues should be promoted in the development a climate smart toolkit.

Recommendation 1.3: The concept and approach of climate smart aquaculture is relatively new in the aquaculture sector, yet it subsumes the potential to improve adaptation, mitigation and increasing productivity of the fish farms. The department of fisheries and NGOs should promote integrated systems for adaptation of the farming system.

Recommendation 1.4: The Policy environment is generally supportive although practices on the ground call for a revisit of the policy on introduction of exotic species. Government should use emerging evidence to reconsider the banned fish species which are preferred for fast growth which will boost the productivity of the industry and further help adapt to climate change.

Promoting Ecosystem-Based Adaptation Strategy: Competing use of the watersheds in fishpond located areas is one of the major challenges which farmers are facing. Fish farmers are often working in isolation from crop-based or livestock-based farmers. Most watersheds are now degraded. The stabilizing mechanisms that would otherwise allow the fishponds to be resilient from both flooding and droughts have been eroded. Autonomous adaptation taking place in high-risk areas will accelerate as climate impacts become more visible and awareness spreads.

Recommendation 2.1: Create an enabling environment for autonomous adaptation through strong social capital, effective community-based organizations, strong collaboration and coordination of a wide range of diverse interest groups.

Recommendation 2.2: Promote investment in ecosystem rehabilitation, repair and development in watershed areas for long-term sustainability of the different farming systems.

Improving Business Enabling Environment: Aquaculture as a business suffers from low investment in the sector. Smallholder farmers lack business development services and extension services to promote their business skills. As the Climate Smart aquaculture toolkit is developed these areas are critically important to consider.

Recommendation 3.1: Fish farms individually owned by women are few, this is largely due to the high labour requirements and costs associated with construction of fishponds. The group owned fish farms, however, accommodate women but these farms are poorly performing. Financial support is required if women are to meaningfully participate in aquaculture development.

Recommendation 3.2: As the aquaculture industry expands, climate smart aquaculture offers an opportunity for policymakers to collaborate with investors. Furthermore, there is a need for cooperation between different government departments (including business/ industry, finance and environment) so that no new unintended policy barriers are created and – like the business solution – the policy response is designed to maximize system effectiveness. Other society stakeholders, including citizens and consumers, labour unions and environmental organizations, should also be engaged. Investors need to be guided in adaptation and environmental, and climate change mitigation measures.

Recommendation 3.3: Lack of better performing indigenous fish species is integral to the barriers to efforts to increase the aquaculture productivity in the country. Prevailing rules and regulations prevent the introduction of exotic fast-growing species with higher weight. Government should initiate a revisit of the ban of exotic species

2 Harvey, B., Soto, D., Carolsfeld, J., Beveridge, M. & Bartley, D.M., eds. 2017. Planning for aquaculture diversification: the importance of climate change and other drivers. FAO Technical Workshop, 23–25 June 2016, FAO Rome. FAO Fisheries and Aquaculture Proceedings No. 47. Rome, FAO. 166 pp.

which has recently become an issue of public debate. A comprehensive and integrated risk assessment of likelihood impact is required before the lift of the ban.

Recommendation 3.4: The Department of Fisheries should facilitate collaborative arrangements between large scale private companies such as the Chambo Fisheries Limited and MADECO, with smallholder farmers to accelerate the sector development.

Increasing productivity and household incomes

Recommendation 4.1: Lack of better performing indigenous fish species is integral to the barriers to efforts to increase the aquaculture productivity in the country. Prevailing rules and regulations prevent the introduction of exotic species fast growing with higher weight. Government should initiate a revisit of the ban of exotic species which has recently become an issue of public debate. A comprehensive and integrated risk assessment of likelihood impact is required.

Recommendation 4.2: Fish-crop-livestock integrated farming is the most striking feature of farming observed in the field but practised among few farmers and this can have considerable significance in raising productivity of the farming systems. It is recommended that at least the climate smart aquaculture toolkit will capture variations of the different forms of integration to inform implementation of pilot projects in suitable areas to test the feasibility of such integrated farming and to evaluate the extent and nature of benefits that would accrue under different conditions.

Recommendation 4.3: Promote transition to new species that adapt to the changing climatic conditions, fast growing in local aquaculture situation on locally produced feed; processed/ preserved using green energy; in demand on the local market and environmentally safe.

Recommendation 4.4: Develop an insurance mechanism for aquaculture, as it could protect smallholder fishers against production and climate risks.

Gender mainstreaming in Aquaculture: Almost all development policies recognize the crucial role gender plays in influencing interventions in poverty reduction, food and nutrition security and climate and environmental changes the country is undergoing. However, practice in the aquaculture sector can be strengthened through the CSA approach. Recommendations to do so include:

Recommendation 5.1: Climate Smart Aquaculture can achieve its goals when it fully incorporates women and marginalized groups into program design and implementation. Men, women, and children all play a role in maintaining healthy aquaculture enterprises. For this reason, it is important that both genders be considered and consulted within the CSA toolkit in all matters of planning and decision-making processes.

Recommendation 5.2: Mainstream gender concerns and empower women to contribute to adaptation and mitigation efforts, building on an understanding of the different capacities and vulnerabilities of men and women. Actions could include strengthening women's leadership in fishery organizations, ensuring that new sectoral legislation and budgets reflect women's concerns, and providing women with financial and technical skills, and access to weather and environmental information.

Capacity-building and research

Recommendation 6.1: The aquaculture sector should develop capacity and promote the use of scenario-building methodologies to enable policymakers to identify key features of aquaculture production, as well as the drivers of change, and to understand vulnerability to climate change and climate variability. This helps to create responsive planning scenarios and design evidence-based and coherent adaptation policies and plans at all levels.

Recommendation 6.2: Strengthen the knowledge base and climate change advisory capacity of fisheries and aquaculture extension workers and revise extension training material to take into consideration the effects of climate change. Such services will play a crucial role in disseminating knowledge in remote fishing and aquaculture communities. Well-trained extension workers

and extension material incorporating climate risks will be key.

Recommendation 6.3: Strengthen the capacity of relevant agencies and authorities to monitor and disseminate information on the occurrence of disease in fish farms and harmful algal blooms, including red tides and ciguatera, which may increase due to climate change, especially in areas known to be vulnerable to eutrophication.

Recommendation 6.4: Promote innovation, research and technology development: adapt to changing environmental conditions by developing new strains of aquaculture species tolerant to low water quality and high temperatures, and resistant to disease, while enhancing disease control systems in aquaculture.

Proposed Financing Models: Aquaculture farmers often lack access to financial services for their capital expenditures and working capital. Improving availability of credit and saving products to enable financing of SHFs will remain a major option for mitigation and adaptation to climate change. Credit system will require appropriate financial institutions, better understanding of the sectors and building capacity to reduce risk. Saving and credit groups are alternatives to formal financial institutions. Banks in the country often have limited understanding of the aquaculture sector and find it hard to identify bankable opportunities. Borrowing from the Indonesian experience, we propose three possible solutions: to share risks along the value chain; to provide credits after the breakeven point and to use crowdfunding. The following are major recommendations to realize these solutions:

Recommendation 7.1: Promote a risk-sharing model by addressing risks and risk mitigation from multiple players, protecting the lender, the company, or the bank. Sharing the risk along multiple actors in the value chain reduces the risks in two ways (i) the costs are shared along the value chain; (ii) if multiple parties play a role in the arrangement, the risks themselves are reduced because the value-chain players are better connected, and collaboration is increased.

Recommendation 7.2: Increase availability of credit and saving products to enable financing of adaptation. Credit systems will require appropriate financial institutions, better understanding of the sectors and building capacity to reduce risk. Saving and credit groups are alternatives to formal financial institutions.

CHAPTER 1: INTRODUCTION

1.1 Background and Objectives

1. **This synthesis report is prepared for policymakers, potential and operating investors in the aquaculture industry in order to stimulate their interest to take part in the aquaculture sector transformation for poverty reduction through climate smart aquaculture as a model of development**. The report summarizes the sector and its potential for investment that takes into consideration of the most vulnerable smallholder farmers. It presents analysis of climate change risks, adaptation and mitigation options, and proposes possible financial models to stimulate sectoral growth. Its objective is to inform one of the deliverables stipulated in the Terms of Reference on the assignment: *Development of Climate Smart Aquaculture Toolkit*. The toolkit will provide guidance on the transition toward climate smart aquaculture approach to bring about lasting benefits of a more innovative, resilient and productive aquaculture subsector in Malawi.

2. **The fisheries and aquaculture provide essential nutrition, support livelihoods and contribute to national development in Malawi.** Fish provides over 70 per cent of the dietary animal protein intake for Malawians and 40 per cent of the total protein supply. They also provide vital vitamins, minerals and micronutrients[3]. Much of the fish is consumed in rural areas thereby contributing significantly to daily nutritional requirements to some of the vulnerable groups such as HIV and AIDS victims, orphans and the poor (Economic Report 2011). Fishing is the main source of livelihood to 37,089 out of 3,984,981 households in Malawi (NSO, 2018). The sector directly employs nearly 59,873 fishers and indirectly over 500,000 people who are involved in fish processing, fish marketing, boat building and engine repair. Furthermore, nearly 1.6 million people in lakeshore communities derive their livelihood from the fishing industry. The main provision of the fishery resource comes from capture fisheries. Sustainable fisheries contributes 3 percent to the national GDP, and government has set a target of 3.8% to be achieved by 2022 in partial fulfilment of MGDS Key Priority Area 1: *To achieve sustainable agricultural transformation that is adaptive to Climate Change* (GoM, 2017).

3. **However, the sector faces significant challenges in maintaining its crucial contribution to these areas.** Population pressure on land has resulted in environmental degradation that has consequently reduced benefits that the population derives from the environment (ecosystem services) as shown by reduced stream flows, and decline or extinction of fish, among other challenges. Malawi is an agrarian-based economy which largely depends on its abundant environment and natural resources for economic development. More than half of its population live in extreme poverty and experience food insecurity for at least one month of the year, mostly relying

3 Njaya F. (2018): Ecosystem approach to fisheries in southern Lake Malawi: Status of the fisheries co-management

on forest-based natural resources and raw materials for biomass energy and income[4]. The deforestation rate in Malawi is one of the highest in Africa at 35% and this has contributed to prolonged dry spells, severe droughts and floods, putting a lot of pressure on the country's few natural resources. Fish used to be the most affordable source of animal protein in Malawi up to the early 1990s, but rising costs, overfishing, decreasing supply, increasing population and increasing fish exports have reduced domestic per capita fish consumption from 9.4 kg to 4.9 kg per annum between 1990 and 2011. In terms of protein supply from freshwater fish, statistics show that this has dropped from 2.34 grams to 1.4 grams per capita per day.

4. **To achieve the goal of food security and national fisheries development goals in the face of population growth, environmental degradation and climate change, adoption of climate smart aquaculture is urgently needed.** The growing interest in aquaculture investment provides an impetus to sustained fish production for local and export markets (GoM, 2016)[5]. With increased fish production from both capture fisheries and aquaculture coupled with value added initiatives, it is expected that fish exports will also increase by focusing on targeted markets that will include both high and low value fish products mainly destined for the regional market (GoM, 2016). The aquaculture sub-sector has the potential to increase fish production in the country. Enhanced aquaculture production, especially at a commercial level, would improve the supply of fish protein in rural areas far away from the major fish production sources and creation of wealth and employment in such areas. The aquaculture subsector can also be one of the major sources of fish product exports, thereby contributing to Malawi's economic growth. There are 6,000 fish farmers with varying sizes of ponds in the aquaculture subsector. Fish production in the sub-sector has been increasing from an estimated 800 tonnes per annum in 2006 to 3,600 tonnes per annum by 2015. However, one of the major problems identified with commercial aquaculture is that the species cultured are slow growing and have a poor feed conversion, making the products of aquaculture expensive to produce (GoM, 2016).

5. **Achieving climate smart aquaculture *per se* requires understanding multiple objectives such as employment, food production, economic efficiency, poverty reduction, biodiversity conservation, and ecosystem resilience**. These objectives are not always fully compatible, and a conventional form of aquaculture may not currently address all of them. This report examines the issues affecting the aquaculture industry and makes case for the development of Climate smart Aquaculture toolkit to build capacity for poverty reduction, food security, mitigation and adaptation to climate change. To make the toolkit relevant to the challenges facing farmers on the ground, input from various stakeholders was required. This report aims to inform the development of an actionable toolkit to help accelerate the transition towards climate smart aquaculture. The report, therefore, provides a sectoral analysis to examine the variety of opportunities and challenges involved in transitioning towards climate smart aquaculture. Within the sector, an effective climate smart aquaculture approach requires the combination of many policy interventions and does not rely on a 'silver bullet' or blanket solutions. From a business perspective, policymakers need to address market and regulatory failures to create the right enabling conditions for climate smart aquaculture to reach

4 2016 World Bank report

5 The National Fisheries and Aquaculture Policy of 2016, Malawi, Lilongwe.

scale. They can also more actively steer and stimulate investments in the sector.

1.2 Approach to the Synthesis

6. Methodologically, the report has been prepared through a desk review supplemented with qualitative data collected through field consultations and expert opinion. A list of stakeholders consulted has been attached in Appendix 1. Key informant interviews targeted District Fisheries Officers and Focus Group Discussions were administered among fish farmers in seven (7) districts including Mzimba, Rumphi, Chitipa and Karonga in the North. Districts in the South included Mangochi, Balaka and Phalombe. However, Salima was the only district visited in the central region. These districts were purposively selected based on their experiences on climate change. However, some districts such as Mzimba were selected based on the existence of smallholder farmers adopting climate smart aquaculture practices. Mzuzu Aquaculture Centre was consulted taking advantage of its long-term experience in working with smallholder farmers as a demonstration center. A validation process on policy matters was undertaken with decision-makers which helped to deepen the consultant's understanding of the specific roles of the Fisheries Department in policy processes. The problems and opportunities in the core market and the corresponding support and business-enabling environment functions were based on the recent sector review by the CASA strategy. As such, this document draws from multiple sources, including secondary information from a literature review and primary information obtained through various focus group discussions and key informant interviews.

CHAPTER 2: SECTOR STRATEGIC ANALYSIS

2.1 Promising Global Trends and Market Potentials

7. Global statistics signal prospects for investment in the aquaculture business. In 2014, the industry surpassed global capture fisheries production and until now remains the world's fastest growing food sector. The market for aquaculture in 2017 was valued at $176 billion, with an annual growth of 5.8 percent. In sharp contrast, the commercial fishing industry was sized at $241 billion in 2017, having increased by 2.3 percent from the previous year. Projections show that, if these trends continue, then the global aquaculture industry will transcend commercial fishing by 2026.

Table 1: World Fisheries And Aquaculture Production, Utilization And Trade[6]

	1986-1995	1996 - 2005	2006 - 2015	2016	2017	2018
	Average per year					
	(millions tonnes, live weight)					
Production						
Capture						
Inland	6.4	8.3	10.6	11.4	11.9	12.0
Marine	80.5	83.0	79.3	78.3	81.2	84.4
Total capture	86.9	91.4	89.8	89.6	93.1	96.4
Aquaculture						
Inland	8.6	19.8	36.8	48.0	49.6	51.3
Marine	6.3	14.4	22.8	28.5	30.0	30.8
Total aquaculture	14.9	34.2	59.7	76.5	79.5	82.1
Total world fisheries and aquaculture	101.8	125.6	149.5	166.1	172.7	178.5
Utilization						
Human consumption	71.8	98.5	129.2	148.2	152.9	156.4
Non-food uses	29.9	27.1	20.3	17.9	19.7	22.2
Population (billions)[3]	5.4	6.2	7.0	7.5	7.5	7.6

6 Excludes aquatic mammals, crocodiles, alligators and caimans, seaweeds and other aquatic plants. Totals may not match due to rounding. Source: FAO, 2020. The State of World Fisheries and Aquaculture, Rome.

Per capita apparent consumption (kg)	13.4	15.9	18.4	19.9	20.3	20.5
Trade						
Fish exports – in quantity	34.9	46.7	56.7	59.5	64.9	67.1
Share of exports in total production	34.3%	37.2%	37.9%	35.8%	37.6%	37.6%
Fish exports – in value (USD billions)	37.0	59.6	117.1	142.6	156.0	164.1

8. Global fish production volumes and value peaked in the year 2016, registering about 171 million tonnes, which was valued at about $362 billion3. Of the total production volume, 47% represented aquaculture production if non-food uses (such as fishmeal and fish oil) are included or 53% if non-food uses are excluded. Of the total sales value, $232 billion was from aquaculture production. It is noteworthy that production levels from capture fisheries have been relatively static since the late 1980s, and that continued growth in fish supply has largely been possible thanks to growth in aquaculture production. This trend has continued and even accelerated in recent years (**Table 1**).

2.2 Growing National Trends with Potentials

9. Over the past few years, the sector has displayed signs of growth[7]. Total annual production volumes reached an all-time high of 164,940 tonnes in 2016, up from about 81,400 tonnes in 2005 and 100,900 tonnes in 2010. While the bulk of fish caught, sold and consumed has traditionally been produced by capture fishery, capture fishery production has declined in some years. This has been particularly the case for the commercially-oriented, high-value species such as the Oreochromis karongae - locally known as ‘chambo’ – the average annual production of which declined from more than 10,000 tonnes between 1980 and 1990 to around 4,000 tonnes between 2000 and 2015[8]. On the other hand, annual fish production under aquaculture increased from about 800 tonnes in 2005 to about 4,900 tonnes in 2015 and 7,672 tonnes in 2016. The bulk of fish produced by aquaculture is commercially-oriented, high-value species, which are being caught less by capture fishery (**Table 2**).

7 This section borrows heavily from CASA Strategy.

8 The National Fisheries and Aquaculture Policy of 2016

Table 2: Trends in Malawi's annual fish production and growth for capture and aquaculture[9]

Year	Capture (tonnes)	% Growth in capture fisheries	Aquaculture (tonnes)	% Growth in aquaculture	Total (tonnes)	% Growth in capture & aquaculture
2005	80,609		813		81,422	
2006	72,929	(9.5)	907	11.6	73,836	(9.3)
2007	67,818	(7.0)	1,252	38.0	69,070	(6.5)
2008	75,867	11.9	1,318	5.3	77,185	11.7
2009	76,045	0.2	1,600	21.4	77,645	0.6
2010	98,300	29.3	2,632	64.5	100,932	30.0
2011	82,336	(16.2)	2,815	7.0	85,151	(15.6)
2012	120,328	46.1	3,232	14.8	123,560	45.1
2013	109,889	(8.7)	3,705	14.6	113,594	(8.1)
2014	116,289	5.8	4,742	28.0	121,031	6.5
2015	144,315	24.1	4,918	3.7	149,234	23.3
2016	157,268	9.0	7,672	56.0	164,940	10.5

Source: Department of Fisheries

9 Fish production data was obtained from Department of Fisheries

10. **CASA strategy also noted that the number of Malawians engaged in fisheries and aquaculture has also increased.** The sector employed 173,328 Malawians in 2016, including 7,139 that engaged in aquaculture[10]. By 2018, the number of aquaculture fish farmers had grown to about 15,465, according to a census carried out by the Department of Fisheries[11]. Most of these are SHFs organised in farmer clubs, and only two players are operating at a commercial level. In terms of gender, 61.5% of the SHFs are male, and 38.5% female.

11. **Fish farming is primarily done for commercial and semi-commercial purposes by almost all producers in Malawi including smallholder farmers, who sell virtually 90% of their production.** Most aquaculture farmer clubs are initially established by NGOs to support nutritional needs, although eventually, they become increasingly more inclined to sell their fish harvests[12]. Since the harvested fish stocks are sold within the locality of the clubs, this practice enhances community nutritional needs.

12. **In terms of pricing and marketing, all fish produced under aquaculture are sold and consumed within the country, with most of the SHFs and farmer clubs selling within their locality.** MALDECO is the only entity selling fish beyond the vicinity of its production sites, supplying most of the major cities and some district towns through its established franchises. Fish colour is the major factor that impacts the price of fish produced through aquaculture: both pond and cage-based farmed fish tend to have a dark colour, but most upmarket consumers prefer a silver colour. It is noteworthy that this upmarket urban niche, particularly in the capital city of Lilongwe, is where duty-free imports of competing fish products from Zambia are also sold.

10 FAO FishStat, SADC Member States, World Bank in the Synthesis Report on the State of Food and Nutrition Security and Vulnerability in Southern Africa, 2018

11 As reported in the Annual Economic Report of 2018 by the GoM

12 The IFFNT membership emphasised this point and attributed the same to the significant income constraints that smallholder farmers do have to cater for their basic needs

13. **The government's intention is to promote aquaculture production to contribute to nutrition and food security by compensating for the dwindling volumes under capture fisheries. But most of the fish currently being produced under aquaculture in Malawi are the commercial Chambo species, which have an average weight during harvesting of between 300 and 800 grams.** The Chambo is now too expensive for the nutritionally constrained segment of the population, who are in the lower-income brackets. As such, most of the aquaculture-produced fish is sold to middle-income urban consumers. To cater for lower-income urban consumers, Chambo Fisheries purposefully harvests some smaller fish sizes, between 150 and 300 grams, and sells them to this segment of consumers.

14. **One major constraint to increased volumes of production is fingerlings. The small-scale fingerling producers comprise hatcheries operated by smallholder farmers.** Most of these are members of the Innovative Fish Farmers Network Trust (IFFNT), a grouping of upcoming micro, small and medium aquaculture players (Table 3).

15. **Since most SHFs are unwilling to pay for quality fingerlings, the private hatcheries do not have adequate demand for their fingerlings**, which depresses fingerling production levels. Those SHFs that use quality fingerlings mostly purchase with the help of NGOs and the government, reducing the incentive for investment[13] in fingerling production.

16. **The second layer of the challenges facing smallholder farmers is that the country does not have commercial producers of floating fish feed. Its high protein-conversion ratio makes it the appropriate feed type for aquaculture-based production, whether this uses ponds or cages.** Sinking feed, on the other hand, has low uptake because most of the feed ends up accumulating at the base of the pond or wasted in the water reservoir in the case of cage-based production. From a climate smart aquaculture perspective, floating feed is regraded climate smart because the proportion of decomposing feed can be reduced thereby enhancing the mitigation potential of the sector. NAC has just installed a feed mill that can produce floating fish feed. However, the capacity is too small to support any commercial production needs of SHFs. Secondly, NAC is still testing this equipment, which was procured under the now phased-out AgriTT Project. So, the equipment has not been fully commissioned. The Lilongwe University of Agriculture

13 Sector Analysis Studies for CASA: Malawi Country Value Chain and Market Analysis Report, CARDNO, November 2017.

Table 3: Capacity of small-scale private hatcheries (by number of fingerlings produced)

#	Name of the private hatchery	**Total capacity** (Number of fingerlings)	**Current production level** (Number of fingerlings)
1	Chonona Fish Farm	120,000	Not yet started
2	Viphya Chambo	100,000	40,000
3	KA-Small Fish Farm	100,000	50,000
4	Aglupenu Investments	2,000,000	Based on demand
5	African Novel Resources Ltd	400,000	Based on demand
6	Fulamuchenga (individual Producer)	100,000	32,000

and Natural Resources (LUANAR) also procured similar equipment with financial support from the AgriTT Project, but this has not yet been installed because the construction of its housing facility has not yet been completed.

17. **There are opportunities to address the challenge of producing floating feed available to smallholder farmers**. First, the Chambo Fisheries produces slow sinking feed but uses this for its own internal production needs and does not supply it to other players. While MALDECO invested in a feed mill, it has stopped using it, because it was only producing sinking fish feed, which was observed to have significant performance deficiencies compared with floating fish feed imported from Zambia. Meanwhile, MALDECO is only using imported feed from Zambia. These companies provide hope for a partnership with smallholder farmers to make access to floating feed on economic terms. However, the challenge remains the low level of demand which can be resolved through deliberate policy intervention that encourages more farmers to appreciate the value of floating feed.

18. **Other potential producers of floating feed include Chonona Fish Farms and Lenziemill Milling Company.** Chonona Fish Farm has procured a medium-sized feed mill capable of producing floating fish feed. However, installation of this equipment is awaiting completion of the construction works for the anchorage and housing facility. With a capacity of about 100 kg per hour – compared with a monthly internal feed demand of about 250 kg – Chonona's feed mill could potentially service other SHFs. Lenzie mill, a local SME currently involved in production of poultry feed and aggregating agri-produce for export, is also planning to procure a floating fish feed mill with a capacity of between 300 and 800 kg an hour, depending on demand.

2.3 Environmental Considerations

19. The aquaculture industry faces a unique set of risks stemming mainly from its capital-intensive requirement, environmental and climatic changes, and the possibility of diseases that affect farmed fish. Risk mitigation is instrumental to boosting investment, most importantly addressing the impacts of climate change and climate variability. For example, droughts and floods have recently increased with the potential to frustrate further investment in the sector. Malawi has experienced a decline of commercially important fish species like Chambo (*Oreochromis spp*.) from around 30,000 Mt /yr. in the late 20th century to about 2,000 Mt annually in recent years from Lake Malawi. Environmental degradation and climatic influences result in reduced water levels and disrupt fish breeding and nursery sites.

20. **Aquaculture is a pathway of invasive alien species such that their negative feedback on biodiversity, environment and economy can be serious.** Invasive alien species are the second greatest threat to biodiversity globally, and in freshwater systems, introductions lead to biodiversity loss both directly through biotic interactions, such as predation, and indirectly by decreasing the availability of resources, facilitating the spread of pathogens and parasites, or hybridising with native taxa (Vitule, Freire & Simberloff, 2009). In Malawi, the intentional use of non-native species has resulted in the loss of biodiversity. Two invasive fish, Oreochromis niloticus and O. leucostictus, believed to have escaped from aquaculture facilities have recently been found in the Lake Malawi catchment in Tanzania (Genner et al., 2015), and the introduction of other freshwater fish for aquaculture, such as Cyprinus carpio, Micropterus

salmoides, and Salmo gairdnerri, is cause for additional concern. Numerous endemic, endangered and threatened aquatic fish species in other lakes and rivers in Malawi will be lost unless measures are put in place to prevent the introduction and spread of these invasive fish species. Elsewhere, the Nile tilapia (*Oreochromis niloticus*) and the Nile perch (*Lates niloticus*) were both introduced to Lake Victoria and are thought to have been responsible for the loss of over 200 endemic cichlid species.

21. **Aquaculture engenders environmental externalities, the extent of which depends on the intensity of the system of production.** Broadly classified into three groups on the basis of feed/ fertilizer input (Edwards, 1990)[14] the systems include: (i) extensive systems which rely on natural feed produced without intentional pond inputs in the form of feed/fertilizers (ii) semi-intensive systems which depend on fertilization to produce natural feed *in situ* in the pond and/or on feed given to the fish to complement the natural feed which develops in the pond, and (iii) intensive systems which depend on nutritionally complete feeds, either in moist formulations or in dried pellet form, with fish deriving little or no nutrition from natural feed production in the pond. Thus, the more intense the system, the larger the environmental effects generated.

22. **Both aquaculture and hydroponics impose negative impacts on the production environment.** Hydroponics requires expensive nutrients to feed the plants and involves periodic flushing of the systems which can lead to waste disposal issues. Sinking fish feed, on the other hand, decomposes and biochemical processes turn it into methane and other gases responsible for global warming. The type and scale of any ecological change related to aquaculture development will depend on the method, the level of production and the physical, chemical, and biological characteristics of the area in question.

23. **There is a general understanding that freshwater extensive aquaculture which is practised in lakes and reservoirs is the least destructive system; even this can generate some negative environmental effects.** These include the eutrophication of water bodies, spoiling of the beauty of the environment, destruction of ecosystems, public health risks, and the displacement of stocks. However, the environmental impact of this kind of system is less than for more intensive systems which utilize larger amounts of inputs (Barg, 1992[15], Martinez-Espinosa and Barg, 1990, Pullin, 1989). Most tropical inland aquaculture is semi-intensive, generally relying on the use of plant-based agricultural by-products as feeds with very variable feeding rates that are usually empirically derived (Beveridge and Phillips, 1990). Environmental effects include health risks to farm workers from water-borne diseases such as schistosomiasis and salinization/acidification of soils and aquifers. It is also possible that heavy metals from livestock feed in integrated aquaculture can accumulate in fish and pond sediments. Semi-intensive systems often cause less environmental disturbance than larger and more intensive systems, particularly if they are integrated with agriculture (Barg, 1992, Pullin, 1989, Pullin, 1990[16]).

14 *Edwards, P.* 1990. Environmental issues in integrated agriculture-aquaculture and wastewater-fed fish culture systems. Conference on environment and third world aquaculture development, Rockefeller Foundation, Bellagio, Italy, 17-22 September 1990.

15 *Barg, U.C,* 1992, Guidelines for the promotion of environmental management of coastal aquaculture development. FAO Fisheries Technical Paper No 328.

16 *Pullin, R.S.V.* 1990. An overview of environmental issues in third world aquaculture development. Conference on environment and third world aquaculture development, Rockefeller

24. **Intensive aquaculture depends on the use of formulated feeds which supply all or almost all of the animals' nutritional needs.** Aeration and automatic feeders are also often employed, and as a result production costs are high, limiting culture to high-value species (Beveridge and Phillips, 1990). However, intensive systems may be appropriate for rearing high-value species such as salmonids in temperate waters. Environmental effects include eutrophication due to aquaculture effluents high in BOD^2 (biological oxygen demand) and suspended solids and the accumulation of anoxic sediments below cages (Barg, 1992, Pullin, 1989).

2.4 Policy and Legal Instruments

2.4.1 Global Instruments

25. A review of global instruments clearly shows that aquaculture development is referenced in different thematic areas of international law, with a focus on the relationship between multilateral environmental agreements and trade-related agreements[17]. This presents an opportunity to effectively guide the promotion of CSA. Malawi is a member of several global and regional organizations and conventions relevant to aquaculture development. The list is too long to exhaust but the most relevant to the list include World Trade Organization (WTO), International Plant Protection Convention (IPPC), the Office of International des Epizooties (OIE), Codex Alimentarius Commission (CAC), Inter-African Phytosanitary Council (IAPSC), Multilateral Environmental Agreements (MEAs) such as the Convention on Biological Diversity (CBD); the United Nations Framework Convention on Climate Change (UNFCCC); the Cartagena Protocol on Biosafety (CPB); the Convention on International Trade in Endangered Species of Wild Fauna and Flora, Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat, and the United Nations Convention on Combating Desertification (UNCCD) the FAO Code of Conduct for Responsible Fisheries (CCRF) of 1995.

26. The Code of Conduct for Responsible Fisheries (the Code), unanimously adopted by FAO Members in 1995, is a foundational document that sets out globally agreed principles and standards for the use of fisheries and aquaculture resources, including through regional mechanisms and cooperation, to ensure sustainable use of aquatic living resources in harmony with the environment. The Code facilitates and promotes technical and financial cooperation for the conservation and management of fisheries resources, for research on fisheries and associated ecosystems, and for trade in fish and fishery products.

27. At the regional level, Malawi is a signatory to the SADC Protocol on Fisheries of 2001 and the 2005 Abuja Declaration, both of which call for an end to open access in capture fisheries. Malawi has an obligation related to the International Labour Organization Minimum Age for Employment Convention No. 138 of 1973 and Voluntary Guidelines on the Management of Small-scale Fisheries. Finally, the 1971 RAMSAR Convention on Wetlands is also considered for the principle of wise use of natural resources including fisheries with the participation of the fishing communities

Foundation, Bellagio, Italy, 17-22 September 1990.

17 Secretariat of the Convention on Biological Diversity (2001). Review of the efficiency and efficacy of existing legal instruments applicable to invasive alien species. Montreal, SCBD, 42p. (CBD Technical Series no. 2).

2.4.2. National Policy Frameworks

28. **The Investment in Climate Smart Aquaculture draws policy relevance from many national policies. The goal of the National Fisheries and Aquaculture Policy is to promote sustainable fisheries resource utilization and aquaculture development in order to contribute to food and nutrition security and economic growth of the country.** The Policy makes emphatic recognition of the aquaculture sub-sector's potential to increase fish production in the country and contribute to this ambitious goal. The policy focus on aquaculture is the enhancement of production to the commercial level with the objective to improve supply of fish protein in rural areas far away from the major fish production sources and also creation of wealth and employment in such areas. Based on these goals, aquaculture and its development are strongly linked with other national development polices including: the National Environmental Policy of 2004, the Malawi Nutrition Policy of 2009, National Land Resources Management Policy of 2000, Wildlife Policy of 2000, Water Resources Policy of 2005, Decentralisation Policy of 1998, Gender Policy of 2008, and Malawi National HIV/AIDS Policy of 2013.

29. ***National Environmental Policy (2004):*** The National Environmental Policy of 2004 calls for the development of mechanisms for cross-sector management; facilitating active participation of local communities and other stakeholders in enforcement of legislation; and integration of environmental planning, management and institutional frameworks into the decentralized structure. The most important feature of the policy is the need for Environmental and Social Impact assessment for developments within the sector. The sector provides guidelines for the assessments.

30. ***National Land Resources Management Policy (2000):*** The National Land Resources Management Policy of 2000 aims to promote the efficient and diversified and sustainable use of land resources both for agriculture and other uses in order to avoid sectoral land use conflicts and ensure sustainable socio-economic development. The relevance of National Fisheries and Aquaculture Policy

31. ***Wildlife Policy (2000):*** The Wildlife Policy of 2000 aims to ensure proper conservation and management of wildlife in order to provide for: sustainable utilization; equitable access to the resources; and fair sharing of the benefits from the resources for both present and future Malawians. The protection of biodiversity and ecosystems is at the center stage of this policy and therefore relates to aquaculture.

32. ***Water Resources Policy (2005):*** The overall goal of the National Water Resources Policy of 2005 is sustainable management and utilization of water resources, in order to provide water of acceptable quality and of sufficient quantities, and ensure availability of efficient and effective water and sanitation services that satisfy the basic requirements of every Malawian and for the enhancement of the country's natural ecosystems. Aquaculture creates competing use of water resources relative to other uses. Planning is thus essential for compatibility of use and conflict resolution.

33. ***Malawi Decentralisation Policy (1998):*** The Decentralisation Policy of 1998 seeks to create a democratic environment and institutions in Malawi for governance and development at the local level which will facilitate the participation of the grassroots

in decision making; eliminate dual administrations (field administration and local government) at the district level with the aim of making public service more efficient, more economical and cost effective; promote accountability and good governance at the local level in order to help Government reduce poverty; and mobilise the masses for socio-economic development at the local level.

34. ***Gender Policy (2008):*** The Gender Policy of 2008 seeks to mainstream gender in the national development process in order to enhance participation of women and men, girls and boys for sustainable and equitable development.

35. ***Malawi National HIV/AIDS Policy (2013):*** The goal of the Malawi National HIV/AIDS Policy of 2013 is to prevent HIV infections, reduce vulnerability to HIV, to improve the provision of treatment, care and support for people living with HIV/AIDS and to mitigate the socio-economic impact of HIV/AIDS on individuals, families, communities and the nation. The CSA toolkit will be of great value to these vulnerable groups.

36. **National Resilience Strategy:** The National Resilience Strategy (2018) is a five-year agenda aimed at breaking the cycle of food insecurity. The NRS is linked to UN's Sustainable Development Goals 2 and 13 on zero hunger and climate action respectively. The key areas of focus include agriculture and food security – including supporting diversification, climate smart agriculture and support for fisheries and aquaculture; flood control infrastructure; enhanced early warning systems; and strengthened social protection programmes.

37. **National Invasive Alien Species Strategy and Action Plan (**NISSAP**,** under development**):** Invasive alien species are a significant threat to Malawi's economy as they adversely impact on agriculture, food security and biological diversity. The NISSAP aims to facilitate harmonization of the approach to management of invasive alien species at the national level in order to protect the country's biodiversity, economy, livelihoods, health, and ecosystems and contribute to sustainable development. This national strategy, therefore, is of immediate relevance to the country as a party to the Convention on Biological Diversity (CBD) in tandem with implementation of Article 8(h) of the CBD, namely to "Prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species".

38. **Investment priorities in the aquaculture and other sectors of economic development are guided by the broad adaptation priorities established by the INDC and the Malawi Growth and Development Strategy (MGDS III).** The INDC adaptation priorities include agriculture, water, forestry, fisheries and have gender as a cross-cutting theme. Specific actions identified in the INDC in each of these areas that will be covered by the investment projects are shown in Table 1. Malawi has extremely limited finance for adaptation and the INDC makes a clear case for the need for additional external investment support to drive forward adaptation priorities. The PPCR's programmatic approach allows for a substantive and interlinked set of investments to provide a significant step forward in implementing INDC priorities. MGDS III prioritises climate change and identified a range of climate change related outcomes. MGDS III is the GoM's most recent and key strategic document that reflects current development priorities. The key climate change priorities from MGDS III are shown in Table 2 and the SPCR investments have been chosen because of their coherence and alignment with these.

Table 4: Key priorities in INDC in relation to Climate Smart Aquaculture Approach

INDC PRIORITIES	
Adaptation	Priority sectors and thematic areas: agriculture (crops, livestock, fisheries), water resources, health, infrastructure, land-use planning, transport, population and human settlements, disaster risk management, forestry (wildlife), energy and gender.
Mitigation	Main sectors contributing to GHG emissions are; energy, industrial processes and product use (IPPU), agriculture, forestry and other land use (AFOLU), and waste. Between 2015 and 2040, total annual greenhouse gas (GHG) emissions are expected to increase from the current level of approximately 29,000 Gg CO_2 equivalent to approximately 42,000 Gg CO_2 equivalent, approximately a 38% rise.[1]
M&E	A monitoring and evaluation framework that covers all government programmes and projects implemented in the country. M&E activities are undertaken by MFEPD in collaboration with sectoral ministries, MNREM and other sectoral ministries. External technical and financial support will be needed to establish an INDC tracking system to monitor short, medium and long-term implementation.

Source: GoM, 2015: Intended Nationally Determined Contribution

39. **National Climate Change Management Policy (NCCMP) 2016:** The NCCMP prioritises actions needed to address challenges of climate change, promote climate change adaptation, mitigation, technology transfer and capacity building for sustainable livelihoods[18]. The policy is guided by principles set out in the Malawi Constitution, the United Nations Framework Convention on Climate Change and the Kyoto Protocol. The policy has listed six priority areas:

- Climate Change Adaptation
- Climate Mitigation
- Capacity building, education, training and awareness
- Research, technology development and transfer including systematic observation
- Climate Change Financing

40. **Cross-cutting issues: population, gender and disadvantaged groups:** While the long-term goal of NCCMP is to reduce the socio-economic impacts of adverse effects of climatic change, in the medium-term, NCCMP aims to improve community resilience, sustainable livelihoods and reduced GHG emissions.

41. Developments in the fisheries and aquaculture sector is guided by the National Fishery and Aquaculture Policy (2016) which is currently being considered for review. The policy seeks to maximize sustainable yields from the national waters of Malawi and man-made water bodies, and further aims to improve the efficiency of exploitation, processing and marketing of quality fish products. It also seeks to promote investment in the fishing industry, rural fish farming units and exploit all opportunities to expand existing and develop new aquatic resources.

42. The policy recognizes the important role of fish in the national economy in terms of provision of protein supply. It is estimated that approximately 70% of animal protein and 40% of the total protein intake for the majority of the rural poor comes from fish, thus guaranteeing a nutritionally balanced

18 World Bank, 2017, *op cit.*

diet to a population suffering from high levels of malnutrition. The fish sector is an important provider of employment and livelihood opportunities, as over 200,000 people are employed in the sector and about 14% of Malawi's population depends on the fishing sector(fishing, processing, marketing, fishing gear fabrication, boat building and other ancillary activities) for their livelihood. The National Fishery and Aquaculture Policy, therefore, aims at maximising the sustainable yield from the national waters of Lakes Malawi, Malombe, Chilwa, Chiuta, from the Shire River, from other smaller river systems and from small natural and manmade water bodies. Besides, it seeks to improve the efficiency of exploitation, processing and marketing.

43. The policy then proceeds to present a balanced outline of government's commitment to the various activities to be implemented which are aimed at increasing fish stocks through improved management practices. These include specific goals, objectives and implementation strategies on: fisheries extension, fisheries research, fisheries training, aquaculture development, community participation in fisheries management, policy and legal framework enforcement and private sector involvement. It also discusses the institutional framework and monitoring and evaluation arrangements.

44. **Emerging trends display a growing aquaculture industry in Malawi although the sector remains less competitive at regional level.** Trends in aquaculture in Malawi are not competitive enough within the region, although promising growth of the sector has recently emerged. A recent report reveals that Malawi's aquaculture production levels are insignificant on both a global and a SADC region level, because the sector remains largely under-developed. In the SADC, Malawi's aquaculture production contributed only 5% of the regional total in 2016 and was ranked sixth, after leading producer countries including Zambia, Madagascar, Tanzania, Zimbabwe and South Africa. This remains the situation despite the country's enormous freshwater endowment compared to other SADC countries. The report further noted that the country's fish production still falls short of national demand, attracting supplementary fish imports

Table 5: Summary of available and potential feed-making investments

#	Producer/ potential producer	Type of Feed	Operational (Yes/No)	Capacity (kg/hr)	Remarks
1	Chambo Fisheries	Partial floating	Yes	Not yet provided	Internal use only
2	Chonona Fish Farm	Floating	Not yet	100	Equipment just procured. Installation awaiting completion of housing facility
3	NAC	Floating	Partly	100	Finalising testing – primarily for research purposes but can supply a few SHFs
4	LUANAR	Floating	Not yet	100	Equipment not yet installed. Awaiting construction of housing facilities. Primarily for research purposes but can supply some SHFs
5	Lenzie Mills	Floating	Not yet	300 -800	Equipment not yet acquired. Procurement process still underway

from Zambia.

45. **Due to weak access to formulated feed, some SHFs use organic and inorganic fertilisers, mostly with the support of projects and NGOs.** On the other hand, most of the SHFs without project or NGO support tend to use locally sourced chicken manure, rice and maize bran with significant depressing effects on productivity.

46. **The most pertinent cross-cutting issue at the input supply node is the environmental implications of releasing wastewater from fingerling production ponds.** This results from prevailing weaknesses in enforcing proper environmental mitigation measures, and most of the small-scale producers tend to release wastewater back into source water bodies, such as rivers.

47. **The CASA strategy documents that the main actors in the production node include the two major commercial producers, MALDECO and Chambo Fisheries,** plus 15,465 registered SHFs spread across the country[19], of which only about five show some signs of capability to step-up their production. Among those with the ability to step up, only Viphya Chambo has a woman as a registered owner – she is working closely with her husband on the enterprise. The rest are owned and operated by men. Similarly, youth involvement in the potential stepping-up of aquaculture production is not evident, due to high initial investment costs. As such, the production function in aquaculture is currently skewed towards men, with women largely involved through small-scale producer farmer groups.

48. **There is currently very little interaction among actors in this node of the value chain**, perhaps only among the SHFs. That is, some of the SHFs noted as potential stepping-up producers provide some extension support to fellow SHFs in their catchment areas.

49. **In terms of production technologies, MALDECO is the only company engaged in cage farming, after initially trying to use pond-based production technologies.** The company has over the past couple of years been working on testing the viability of cage culture and is now confident of pursuing this as its main production technology. MALDECO produced 712 tonnes of fish in 2018 but has the capacity to produce much more.

50. **On the other hand, Chambo Fisheries uses a bio-flow system with a combination of an artificially controlled water recirculation system** and specialised machinery to filter dirt from the water that serves the breeding and production tanks. Meanwhile, Chambo Fisheries produces about 800 tonnes of fish annually but has the capacity to produce 20,000 tonnes. The company is not able to exploit its installed capacity because of significant cash flow challenges emanating from high operational costs associated with its recirculation production system.

51. **In contrast, all SHFs produce fish through upland pond-based farming technologies.** These ponds are mostly communal and owned by farmer groups. Only a few ponds are owned by individual farmers due to the high costs of pond construction, which put them out of reach of most individual SHFs. Individual women are seldom engaged in aquaculture, but most farmer groups include women members. This reflects a traditional mentality that fishery enterprises are largely male activities, as well as limited awareness that they can be structured as household enterprises

19 *Source:* The Department of Fisheries, based on a census carried out by the Department in 2018. It must be pointed out that some of these fishers may not be active because they tend to be lured into joining producer clubs when there is a new project and go into hibernation soon after the project is phased out.

with collective input (land and labour) and benefits for men, women and children. In addition, the entry of women and youth is hampered by high initial investment costs related to the construction of ponds, even if most women in Malawi do have access to land. As expected, the sizes of ponds vary between farmers and farmer groups. The Department of Fisheries recorded 10,007 active fishponds in 2018 covering a combined area of 251.6 hectares[20] (See Figure 1).

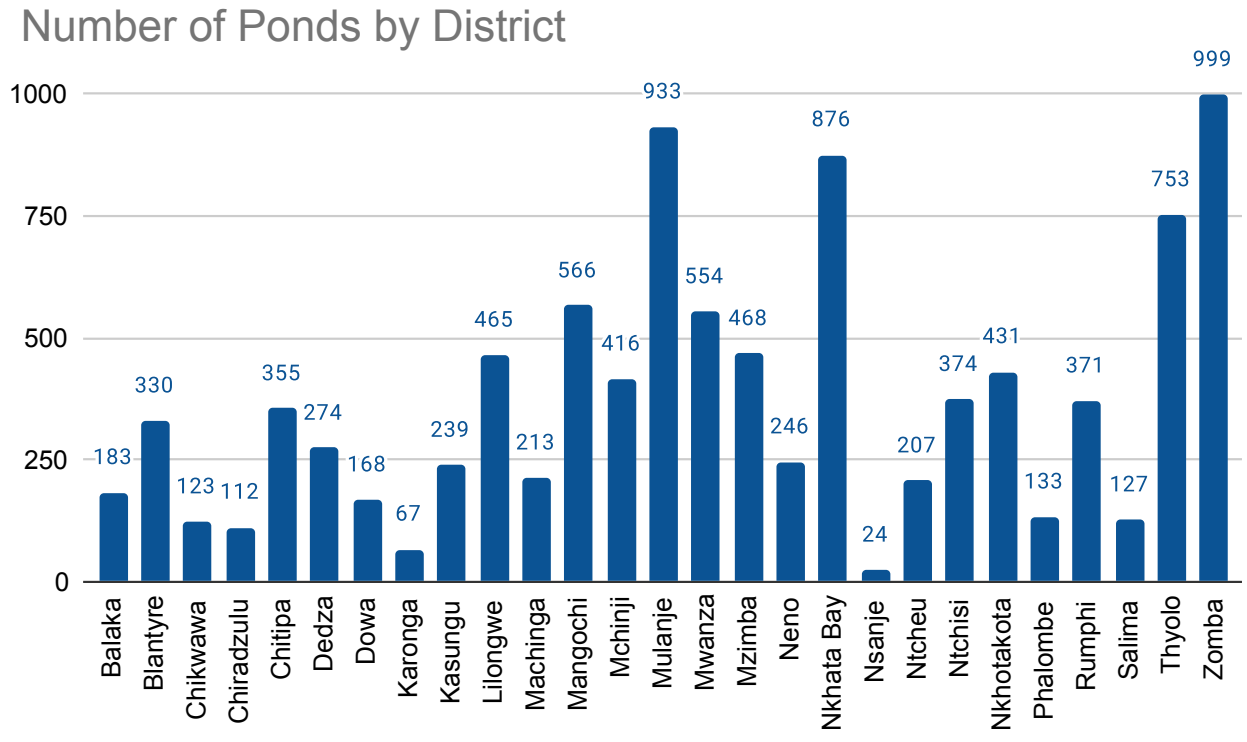
52. The production technologies described above have considerations for climate change and the environment. Cage farming technology involving the installation of cages – probably in Lake Malawi – would ordinarily require thorough prior assessments to identify the potential environmental impacts of possible changes in water quality parameters. These would have to be followed by appropriate mitigation measures. The possible consequences of cage culture include reduced dissolved oxygen and increased ammonia concentration in and around the cage, resulting from the high fish densities and feeding rates[21]. Research and testing may show that this negatively impacts the environment by causing anoxic conditions in sediments (due to organic enrichments) underlying the cages, thus changing the abundances and compositions of the invertebrates[22]. Water hyacinth is yet another massive problem. It is supported by nutrient runoff, principally from land-based farming but also from cage culture. Research and testing would also inform proper site selection.

53. There are also considerations related to climate change for pond-based production technologies.

20 The GoM's Annual Economic Report of 2018

21 Masser, M; What is Cage Culture? SRAC Publication No 160, July 2008

22 Ngupula, GW & R Kayanda (2010) Benthic macrofauna community composition, abundance and distribution in the Tanzanian and Ugandan inshore and offshore waters of Lake Victoria, African Journal of Aquatic Science.



Source: Annual Economic Report of 2018, GoM cited by the CASA Strategy.

For instance, climate change has increased the incidences of events linked to extreme weather such as floods and droughts. This is the case in the Lower Shire, which is a key potential aquaculture production site and is faced with more-frequent floods.

54. **Post-harvest handling entails preserving fresh fish to ensure it does not deteriorate before reaching the consumer**. MALDECO and Chambo Fisheries have cold rooms at their factories and refrigerated vans for distribution outlets. Viphya Chambo and Chonona, too, have acquired their own refrigerated vans. However, SHFs simply sell their fresh fish at the farm gate to local consumers soon after harvesting.

CHAPTER 3: A SYNTHESIS OF STRATEGIC ISSUES AND PRACTICES

55. **A transition toward Climate Smart Aquaculture is a building block for the lasting benefits of a more innovative, resilient and productive aquaculture sector.** Investigations conducted in this study suggest that the aquaculture sector is one of the high-risk sectors despite that there are many opportunities underlying profitability. Both financial and non-financial barriers limit further scale-up or hold back the pace of development. When considering aquaculture, financial institutions are often indecisive as the sector has not yet demonstrated its business potential. A more comprehensive assessment of the risk profile of different producers can only be conducted when accurate data on production, risk factors and the associations between these can be conducted over large spatio-temporal scale. According to CASA strategic report, there are numerous problems, at all stages of the value chain, that impede the participation of actors in the market system, particularly small-scale players. The CASA Country Team has prioritised some of these, including production, aggregation, processing and distribution as follows[23].

(i) Low production volumes to meet market demand.
(ii) Use of low-quality inputs by small-scale producers.
(iii) Lack of product aggregation arrangements to support viable investment in value addition through processing, distribution and marketing.
(iv) Lack of knowledge and skills in fish processing for value addition.
(v) Limited access to finance for investment in downstream functions of the value chains.
(vi) Lack of incentives to invest in processing and distribution due to low fish supply by smallholder entrepreneurs.

3.1. Climate Change Adaptation, Mitigation and Profitability of the Aquaculture – Simple Case Studies

56. A simple margin analysis of the aquaculture fishpond was undertaken although the challenge was to get accurate data. Most smallholder farmers could not produce records of their farm business and therefore some could not provide the needed information as provided under Annex 2. The consultant resolved to determine the profitability of two different fish farms where data were completely available. Additional results were based on a case study for Bunda Aquaculture Farm.

23 The synthesis Report borrows heavily from the CASA report especially on the aspects of commercialization of the aquaculture in the country. It is a recent report (2020) with the necessary information for both policymakers and practitioners to benefit.

Case Study 1

Profitability of An Integrated Aquaculture Business – The Bunda Smallholder Farmers Case

Mussa et al (2016)[2] undertook a study in Bunda Area to determine the economic returns of small-scale fish farming in Malawi, Lilongwe. A total of thirty-two small-scale fish farmers were purposively sampled and interviewed using a structured questionnaire. Cost and returns analysis per harvest gave a margin of MK 7,378.12 (US$ 17.2). Further analysis showed that costs of fingerlings, costs of labour, respondent's total area of land, and costs of manure and fertilizer were significant factors affecting the respondent's total revenue. The study identified major problems faced by fish farmers which included high cost of input, predators, inadequate extension visits and drying of ponds. The study then concluded that small-scale fish farming is a profitable enterprise, especially where there is access to high quality inputs, proper management, absence of predators, and when farmers have access to extension services.

25 This paper was a contribution to the 2016 Fifth African Higher Education Week and RUFORUM Biennial Conference.

One of Mwangonde's fish ponds surrounded by bananas

Case Study 2: Profitability Of A Climate Smart Aquaculture System Mwangonde's Fish Farm - Mzimba

57. Initially started in 2011 as a horticultural farm, Mangonde transformed his farm to a prosperous lead fish farm with limited investment capital. The waterlogged area and reliable river water source coupled with supportive Mzuzu Fish Centre services changed the business of the farm to a success story.

58. **Promising Climate Smart Aquaculture Practices:** Mwangonde's Farm comprises 17 fishponds with each pond measuring 40 m by 30 m on average. The fishponds are 1.5m deeper than the

standard size of 1.2m which helps protecting fish stocks from predation. Deeper fishponds also enhance water retention and therefore adapts from limited water availability during dry spells. Mwangonde has an integrated fish-crop-livestock system with a banana plantation as a major crop around the farm. Mwangonde also constructed a dike to control flooding and prevents loss of fish stocks in case of floods. Water is recycled through the system and that also supports the farm during dry periods. However, the farm faces problems of scarcity of quality fish feed. He has to buy floating feed from Zambia which according to him is costly. Like all other farmers in the country, Mwangonde needs fast growing fish species to cut feeding costs and maximize profits.

59. **Profitability of the Farm:** Despite high feed and labour costs, the farm managed to realize positive gross margin of K796,000/fishpond at the time of harvest (**Appendix** 2). Mwangonde believes that with good investment into the farm, the farm will perform with superior economic returns soon.

Case study 3: A lady in a Successful Aquaculture Business

60. Inspired by Dr Chakhuntha, Mrs. Chavula started her farming in 2003 with additional support for fingerlings from Mzuzu Fish Centre. She started with a 10 x10m pond and expanded to more than 6 fishponds. The table below presents her cost benefit analysis; the gross margin for this business is estimated at K1,765,300. The performance of this business is rated satisfactory, at least, based on gross margin analysis. Chavula seems to have the passion and innovative mind. However, her business meets several challenges which include unreliable water supply which is mainly rains. Second is the use of floating feed which, due to covid -19, is hardly accessed from Zambia. Critical issues, therefore, is the use of local feed in case of lack of preferred floating feed. Chavula also suggests that government should provide for feed subsidy and flexibility of key policies on aquaculture. Lastly, is the issue of unnecessary restrictions on the type of species a farmer wishes to grow as is the case in other countries. However, she considers this business a breakthrough to her business.

- **Long-term Plans:** Brilliant is her idea of value addition, she aspires to establish a fish sausage business utilizing the fish from her farm. This is a wonderful idea as an adventure in contributing to improving people's nutrition through this innovative business.
- **Challenges**: Like most farmers visited, the lady desires to grow fast growing species such as the mirror carp although this species is banned due to its threat to the indigenous species. In addition, this business lady faces the problem of accessing quality feed and fingerlings. The low-quality feed which she uses has been affecting productivity of the farm.

Case Study 3 - The AgriTT programme

How can smallholder aquaculture producers in Malawi improve their yields and profitability?

Problem: The aquaculture sector has experienced a range of different initiatives by government, donors and NGOs, but most farmers continue to struggle to improve their production and profitability levels.

Solution: To address this, the AgriTT Malawi Pilot project 'Grow Out' component has introduced Chinese table-sized fish production technologies and practices to a selection of Malawian fish farmers. The Malawi AgriTT pilot project demonstrated a set of technologies and practices that can significantly increase yields. These approaches were tested on-station at the National Aquaculture Centre (NAC), and on-farm with 25 grow out farmers and consisted of the following best practices:

- Construction of large, deep ponds that are on average 1,000 square metres (m^2) and 2 metres deep. These allow for improved water conservation, temperature regulation and limit the effect of predation.
- Utilisation of improved feeds, whether locally produced or purchased.
- Predation control methods such as pond fencing and screening ponds for frogs and tadpoles.
- Use of partial harvesting technique - only harvesting fish that have reached a specified size.
- Use of feeding trays.
- Stocking of 6 fish per sqm
- Use of correct manuring rates
- Use of all-male fingerlings as seed
- Integration of aquaculture with other farming activities.
- Record keeping and basic good practice business processes.

The use of these practices proved extremely successful with evidence of yield increases from a baseline of 1.5 metric tonnes (MT) per hectare (ha) to up to 6 MT/ha.

25 semi-commercial smallholder farmers were identified to test the improved production technology, after one growing season this was scaled up to 100 farmers, some operating at lower commercial scales. All participating farmers attended a training course (with technical and business development modules), which was followed up by regular technical backstopping visits to their farms by District Fisheries Officers (DFOs), staff from the NAC, and the Chinese Technical Assistants (TA). The test farmers were supported with access to improved feed, production equipment and high quality fingerlings. All farmers attended a technical demonstration open day and a weeklong farmer to farmer knowledge exchange field trip. All DFOs have attended several training sessions on how to work with farmers, and encourage uptake of best-practice technologies. Production manuals have been produced to support the continuation of activities by the DFOs after the project has been phased out.

Source: *AgriTT Pilot Development Projects*

3.2 Low production volumes

61. The aquaculture sector in Malawi is vulnerable to climate change and the impacts are limited, yet adaptation is limited by many challenges. Climate change coupled with environmental degradation is a serious environmental challenge facing most fish farmers although the degree and nature of impacts vary from region to region. A limited number of farmers across the country have adopted various adaptation measures to climate change although with varied degree of success. Current climate variability has a greater impact on fish farming due to poor and unsustainable agricultural practices, increased deforestation, degraded ecosystems within watersheds, and the reclamation and degradation of wetlands and flood plains. Like the agriculture sector, this puts Malawi's aquaculture industry at greater risk. Projections indicate that climate change will invariably heighten risks and vulnerabilities to existing levels of variability of temperature and rainfall. Even with the levels of uncertainty linked to climate modelling, all recent studies of Malawi's future climate broadly agree that over the next decades: (i) temperatures will rise, causing higher evaporation and consequent water stress; and (ii) high levels of rainfall variability will remain. While there exists less confidence in the exact future patterns of extremes, there is higher likelihood of dry spells and higher likelihood of intense rainfall events. These weather patterns are respectively associated with droughts and floods.

62. The seasonal impact on production depends on the specific weather conditions in agroecological zones. For instance, farmers in high-altitude areas such as the northern region city of Mzuzu are not able to produce fingerlings during the cold months from May to July, which also restricts the production of grow-outs to a single cycle per year. On the other hand, fingerling production and production of grow-out fish can be undertaken throughout the year in low-altitude warm areas such as the Lower Shire and most of the Lake Shore districts of Nkhatabay, Nkhotakota and Salima.

63. Observations in the field revealed that fish farmers in the country have been experiencing climate change in many ways depending on geographical location. In Blantyre the Chambo Fisheries Limited has been experiencing extreme cold temperatures which eventually affect fish production and fingerling growth. Contrastingly, in Salima and Balaka observations have shown that farmers are increasingly facing extreme hot weather conditions resulting in water shortages and drying up of dams before harvesting the fish stocks attain harvesting stage. In some areas including Mzimba, Rumphi and Phalombe, farmers indicated that they face torrential rains which at times result in heavy floods washing away their fishponds. These observations corroborate with the work by CASA noting that the country has already experienced some short-term negative impacts from climate change on aquaculture, and future climate shocks and stressors will become more likely. In March 2019, for example, floods triggered by Cyclone Idai washed away two Chonona Fish Farms fishponds, along with catfish stock that was about to be harvested, resulting in significant sunk costs. Generally, the Lower Shire valley has significant potential in aquaculture production, but the region is vulnerable to extreme climatic events alternating between floods and droughts. Atmospheric warming could change water temperatures, which might impact production. Droughts could decrease the availability of fresh water to fill ponds or tanks. Fish farmers have adopted various adaptation measures to high variability in climate and climate change although registering varied degrees of success.

(a) **Early harvest:** Farmers harvest fish before they are mature to avert the impacts of high temperature which cause reduction in water levels in fishponds, especially before the onset of the next rainfall. This adaptation measure is economically not viable as it affects the profitability of the enterprise although it does not have foreseeable environmental externalities.

(b) **Deeper pond construction and irrigation:** Some farmers construct ponds to the depth of 2.5 m to access groundwater which allows prolonging the period of water availability in the fishponds till the right time of harvest, and the subsequent rains. In Karonga, severe evaporation in dams and ponds results in either drying up or low water levels. It was observed that some farmers in Karonga use natural springs with solar systems to supply water into fishponds. Some farmers pump water from permanent sources such as swamps, lakes and perennial rivers, while others use boreholes to supplement water in the fishponds. The challenge with these adaptation measures concerns the huge costs associated with deeper pond construction, solar panels and water pumps. Fish farmers have heavily relied on projects to be able to access these adaptation practices.

(c) **Greenhouses:** Chambo Fisheries Limited has been using greenhouses to keep fishponds warm to adapt to extreme cold temperatures that affecting fingerling production and growth. However, this technology has worked with limited success as the materials used for the construction of greenhouses have been inescapably subjected to heavy winds which consequently do not last long. Recently, strong winds are associated with climate change as well (Plate 1).

(d) **Selection of fast-growing species sexual segregation:** Considering that in many parts of Malawi, rains fall within a short time and extreme temperatures diminish fast the limited water in the fishponds before stocked fish mature, some farmers keep fast growing species as an adaptation measure. Two fish farmers were observed to be successful in adapting to high temperatures which cause the drying up of fishponds using fast-growing species. Some farmers grow

PLATE 1: Greenhouses areused to adapt to extreme low temperatures which affect fish growth. Heavy winds have destroyed the structure.

PLATE 2: Aquatic weed introduced in one of the fishponds in Salima. The farmer introduced this weed to control excessive water evaporation not knowing this weed could destroy the pond.

male and female fish separately to encourage fast growth. The principle behind fast growth in light of adaptation to climate change is that, it allows quick harvesting before fishponds run short of water.

(e) Maladaptation (Introduction of aquatic weeds)

Nevertheless, some farmers have innovatively adopted simple and small-scale techniques and methods of producing fish feed. It was however, observed that the locally produced feed has the potential for the introduction of invasive weeds.

(f) Integrated crop-livestock-fisheries systems: Most farmers consulted have adopted integrated crop-livestock-fish systems. These systems have advantages in terms of adaptation to climate change, and provide cheap feedstuffs and organic manure for the fishponds, thereby reducing the cost and need for providing compounded fish feeds and chemical fertilizers. By reducing the cost of fertilizers and feedstuffs the overall cost of fish production is reduced and profits increased. There are anecdotal reports that the profit from fish culture is often increased by 30-40 percent as a result of integration. The integration increases overall income by adding pig and/or poultry raising, grain and vegetable farming, etc., which supplement the income from fish farming. Thirdly, by producing grain, vegetables, fish and livestock products, the community becomes self-sufficient in regard to food and this contributes to a high degree of self-reliance. Fourthly, the silt from the ponds which is used to fertilize crops increases the yield of crops at a lower cost and the need to buy chemical fertilizer is greatly reduced. It is estimated that about one-third of all the fertilizer required for farming in the country comes from fish ponds. The integration system is a good example of a climate smart aquaculture practice observed in Chitipa, Karonga and Rumphi besides Mzuzu. In these districts, farmers are growing bananas, and planting trees which also protect the fishponds from the impacts of severe floods in low-lying areas.

PLATE 2: A live banana dike protecting the fish farm from floods. Such diversification demonstrates the farmer's awareness about the need to adapt to the effects of climate change and increase productivity of the enterprise.

PLATE 3: One of Mr. Mangoade's fishponds surrounded by bananas. The fish farm is located south west of Mzuzu City.

PLATE 4: Banana plantation attacked by a disease that causes wilting of the leaves. This was observed in Chtipa Northwest.

PLATE 5: Unknown aquatic weed spreading in a fishpond as observed in Chitipa. The pathway through which the weed was introduced into the pond is not unknown. Fish feed is a potential suspect.

- Integration comes with yet another challenge. An aquatic weed invading a fishpond was observed on the same farm in Chitipa. This weed may been introduced through local fish feed or flooding. The prolific characteristics of this weed is a threat to fish farming in the event that the plant gets out of control (Plate 5).
- Banana diseases are one of the challenges facing this kind of integration system. Unfortunately, extension services are limited in the area, especially in Chitipa district where the problem was spotted.

64. **Mitigation of GHGs emissions is generally limited due to many complex factors beyond the capacity of smallholder farmers who are increasingly facing challenges of accessing the appropriate feed that would allow for reduction in GHG emissions.** While fish farmers are aware of the

impacts of climate change on their fish farming enterprises, they are less so of environmental consequences of some aquaculture practices. For example, fish feed is largely and locally made from a range of raw materials including maize husks (madeya). A few farmers obtain floating feed from Zambian suppliers. The following are key environmental concerns with such kind of feed:

(a) The feeds are based on plants, animals, minerals or even synthetic products. For example, almost all farmers use maize husks (*madeya*) of which the large proportion sinks and decompose. As the aquaculture industry shows rapid growth and development, increasing use of sinking feed raises questions regarding associated greenhouse gas (GHG) emissions. Methane and carbon dioxide are two examples of greenhouse gases which can be produced from decomposing feed materials. These gases are responsible for greenhouse gas effect causing global warming. While there are many options to mitigate GHG emissions in the aquaculture sector, observation in the field has shown that the use of floating feed remains an important measure; however, the country has not adequately invested in this area.

(b) The potential of feeding pens as adaptation measure: Mzuzu Aquaculture Centre provides feed pens in the fishponds which allows fish utilize considerable amount of feed before sinking. While this practice is basically used to reduce feed wastage, it is a potential climate smart aquaculture practice in the sense that, the level of decomposition is reduced, thus reducing potential GHG emissions in the fishponds. Unfortunately, the practice has not been widely adopted. It requires raising more awareness among smallholder farmers.

65. Apart from GHG emissions, water pollution is a growing concern associated with aquaculture. As the sector expands, policies and practices to regulate the sector is critically important. It was observed that, almost all visited fishponds are producing wastewater which has serious implications on the environment. Predominantly, smallholder farmers fertilise their fishponds with organic and inorganic fertilisers. The fishponds are usually adjacent rivers in which case some producers dump the wastewater into the rivers and streams. While some farmers have adopted the crops-fish-livestock systems, the use of waste water for irrigating crops has been adopted. MALDECO has been into caged aquaculture in Lake Malawi which according to CASA report will likely raise environmental concerns. Specific concerns include nutrient loading, the introduction invasive alien species and toxins and consequently the decline of native fish populations. These concerns can be addressed with proper technical guidance.

(a) Environmental auditing and monitoring: In the case of Lake Malawi water pollution, CASA promotes the need for carrying out a "strict environmental audit and monitoring under the World Wildlife Fund/ Tilapia Aquaculture Dialogue (WWF/TAD) International Standards for Responsible Tilapia Agriculture. This is so because the Lake Malawi Ecosystem is highly sensitive and ecologically important for its high endemism.

(b) Wastewater Recycling: Around the world, land-based aquaculture facilities are increasingly being promoted as a more sustainable alternative to open-water fish farms. In land-based aquaculture systems in either ponds or tanks in which water can be recirculated or used to fertilise crop production. Land-based aquaculture systems may provide significant co-benefits through the provision of water

for irrigation and the use of crop waste and livestock manure as inputs into the aquaculture system. CASA notes that the challenge with land-based systems has been their small size, poor construction, and lack of water availability. All these constraints have limited economic growth.

66. **Limited productivity influenced by multiple and complex factors including limited farming technical and business skills, poor feed quality and limited capital for expenses on fertilizer and manure.**

- **Aquaculture productivity remains lower than the potential to realize it. CASA report noted that** despite commercial inclination, most smallholder farmers do not use formulated feed but chicken manure. Others supplement pond fertilisation with locally sourced maize and rice bran. This has implications for productivity levels, which range between 0.9 and 1.2 tonnes/ha for smallholders, compared to about 3.0 tonnes/ha for medium scale producers and a potential of 6.0 tonnes/ha.

- **Limited access to quality feed:** During the consultations with MALDECO and Chambo Fisheries, it was observed that these two companies invest in quality inputs in order to enhance productivity and achieve their commercial objectives. It was learnt that apart from Chambo Fisheries[24], all producers in this category use imported floating feed and fingerlings they have bred themselves. In addition, MALDECO and Chambo Fisheries are making extra efforts to enhance their viability, including investment in genetic improvements in the available fish strains through various techniques such as genetic selection and brood stock selection. While most smallholder producers in this category appear willing to step up their production, almost all have very rudimentary operational arrangements, often with no documented strategic/business plans or financial statements.

67. **Almost in all districts visited, smallholder farmers such as those in Salima, Rumphi, Karonga and Phalombe, farmers are grappling to improve productivity due to poor quality feed and scarcity of stocking fingerlings.** As also observed by CASA report, no actors currently provide fingerlings and feed quality assurance certification services, because the Malawi Bureau of Standards (MBS) needs to have the relevant standards to guide their enforcement role. CASA emphasized that the standards would need to be developed by technical agencies such as the Department of Fisheries, supported by government research agencies such as NAC and LUANAR. These standards would provide the regulator with a clear definition of the minimum standards for each applicable parameter to be used as a benchmark for quality certification.

3.3 The Aquaculture Policy Environment

68. **The national policy environment is generally supportive of the aquaculture sector although practice on the ground remains challenging on several issues that call for policy review.** The main reason for the growing interest in fish farming in the country is the accepted national policy, where the sector has received social and political support and made the sector highly favourable for growth. From the limited consultations we had, in some other districts it appears that the introduction of integrated farming can play a major role in rural development in the districts. Species of fish, crops and livestock to be raised will have to be selected on the basis of local conditions and requirements.

24 Chambo Fisheries use own-produced feed, which is slow sinking

In the northern region, the interest to embark on exotic species of fish such as mirror carps has been raised although currently the issue needs wider consultations for review. Suitable pilot projects will have to be designed and implemented to test the systems and based on the results of such projects, further development will have to be planned. Policy on the ban of fast growing exotic species such as the mirror deemed to threaten indigenous species limit the potential for growth of the aquaculture industry yet, neighbouring countries have lifted this ban, according to one of the participants in the consultations. The following are recommendations urgently needed to act upon:

(a) **Review the policy on the use of fast-growing exotic fish species:** As noted during our consultations, and the CASA report, existing rules and legislations do not permit the introduction to the country of exotic species. Some commercial players have been lobbying the government to change these regulations to allow the introduction of fast-growing exotic species to enhance the industry's productivity and viability. However, the government understandably fears the attendant environmental impacts of disturbing the natural habitat and biodiversity of local water bodies. This regulatory function remains the mandate of the Department of Fisheries, with technical support from research institutions such as NAC, LUANAR, Mzuzu University and WorldFish Centre. There is consensus between the Department and research institutions that the introduction of exotic species may not be environmentally benign.

(b) Chirwa et al. (2017) reiterate on the need to identify a better-performing native aquaculture species that has attracted widespread calls from farmers for a reversal of the common carp ban (GoM, 2011). Slow-growing and stunting native fish species have been cited as a major impediment to aquaculture growth in Malawi (GoM, 2011, 2012). These authors note that the policy provisions are clear on this issue. for example, the National Aquaculture Strategic Plan (NASP) (2005-2015) calls for impact studies to provide information that would form the basis for policy review on the use of carp in Malawi's aquaculture. The National Biodiversity Strategy and Plan (NBSP) also calls for an impact assessment of alien species as potential candidates for aquaculture development in Malawi (Environmental Affairs Department, 2006). The government has emphasized the need to do more research on the ecological impacts of carp before it can consider reviewing its policy (Msiska and Costa-Pierce, 1993; Bandula, 1997; SSC, 2005).

3.4 Gender issues

69. **Gender is significantly an important socio-economic issue in aquaculture in the country with promising dynamics emerging in the sector.** Throughout the consultation process, observations were made that smallholder fish farmers *produce fish through upland pond-based farming technologies.* Most farms are communally owned by farmer groups. Only a few ponds are owned by individual farmers due to the high costs of pond construction, which put them out of reach of most individual SHFs. At an individual level, very few women are engaged in aquaculture, but most farmer groups include women members.

PLATE 1 – SHF group in Rumphi

This reflects a traditional mentality that fishery enterprises are largely male activities, as well as limited awareness that they can be structured as household enterprises with collective input (land and labour) and benefits for men, women and children. In addition, the entry of women and youth is hampered by high initial investment costs related to the construction of ponds, even if most women in Malawi do have access to land. As expected, the sizes of ponds vary between farmers and farmer groups. The Department of Fisheries recorded 10,007 active fishponds in 2018 covering a combined area of 251.6 hectares[25].

70. **While the involvement of women and youth at the production level is currently limited largely to feeding fish in family ponds, studies have established that the role of women and children is significantly higher than that of men in the downstream nodes of the value chain.** This is particularly true for capture fisheries, where women and youth are far more involved in downstream activities, including sale brokerage at landing sites, fish processing such as smoking, local trading and exporting through informal cross-border trade. A 2017 study found that only 1% to 5% of producers in the various nodes of fish production and marketing were women; about 70% of local brokers were women; about 90% of local processors were women; none of the transporters were women; 2% of the wholesale and intermediary traders were women; and about 60% of exporters were women[26]. These results were consistent with findings in an earlier study that concluded that over 70% of informal cross-border trade in the SADC region is undertaken by women[27], and that in Southern

25 The GoM's Annual Economic Report of 2018

26 Manyungwa-Pasani et al. (2017) 'Women's participation in fish value chains and value chain governance in Malawi: A case of Msaka (Lake Malawi) and Kachulu (Lake Chilwa)', Working Paper 45. PLAAS, UWC

27 By Afrika, J-G.K. et al. Informal cross border trade in Africa: Implications and policy recommendations. Africa Economic Brief (Volume 3, Issue 10). Africa Development Bank.

Africa, cross-border fish traders were also predominantly young, with ages below 40 years (between 60% and 80% of traders between Malawi and Zambia were under 40.)[28]

Recommendation: Mainstream gender concerns and empower women to contribute to adaptation and mitigation efforts, building on an understanding of the different capacities and vulnerabilities of men and women. Actions could include strengthening women's leadership in fishery organizations, ensuring that new sectoral legislation and budgets reflect women's concerns, and providing women with financial and technical skills, and access to weather and environmental information.

Increase availability of life, medical, assets and income insurance, and access to social insurance. Coverage against losses of assets and income, and sickness and injuries, as well as a social safety net that would provide support to families in the event of death, would greatly enhance the resilience of fishing and fish-farming communities to weather hazards

3.5 Investment in the Aquaculture Sector

71. Access to finance in the aquaculture sector remains uncertain. The aquaculture policy recognizes that aquaculture is needed to satisfy the growing demand for quality animal proteins in the country. However, the risks associated with aquaculture production and the fragmentation of the sector – especially the inland aquaculture – have limited the appetite for investors to finance the sector, besides services and processing. The CASA report remains a recent and more comprehensive documentation of the commercialization agenda of the aquaculture business examining the investment environment in the country. The CASA strategy notes several barriers to significant investment in the sector:

(a) **Limited R&D investment: The country faces low investment in R & D which inevitably narrows the scope to develop innovative, cost-effective production technologies.** Low-cost production technologies are necessarily important to improve the viability of the sector. Limited research fails to develop local production inputs such as feed and genetically improved species adapted to the various agro-ecological zones. However, funding for such targeted research and trials has not been forthcoming, and the sector is highly dependent on input intensification via quality fingerlings and formulated feed. As a climate smart aquaculture, the challenge emerges in terms failure to meet one of the pillars of climate smart aquaculture which is increased productivity and incomes.

(b) **Limited business development service for producers:** During the consultations with smallholder farmers indications were obvious that producers are willing to expand their enterprises, but they do not have the expertise for their production and reach out to the growing markets. This observation was equally noted by the CASA report. For instance, most do not have expertise in business development and planning, bookkeeping, accountancy or taxation, which constrains their ability to obtain financing and invest.

(c) **Lack of appropriate, affordable investment financing**, largely due to information asymmetry between the sector players and financial service providers. Most investors do not have accurate information about the potential of the sector: They have not invested in the production of good-quality fingerlings, floating feed manufacturing and equipment such as cage making, because SMEs cannot provide information on demand for these products.

(d) **Policy inconsistencies tend to stifle prospects for growth of the sector.** The National Fisheries and Aquaculture Policy

28 By Mussa, H. et al. Assessment of Informal Cross border Fish trade in the Southern Africa Region: A case of Malawi and Zambia (2017). Journal of Agricultural Science and Technology

(NFAP) identifies aquaculture as a priority area, but taxation policy does not support these aspirations.

3.6 Mitigation Potential of the Aquaculture Sector

72. **To understand the emission potential of a fish farm enterprise would entail a total life-cycle analysis which is beyond the scope of this study.** Given the complexity of a life-cycle analysis, the major concern focus of this synthesis is at the production level of the farm. Farmers are using a very wide variety of fish species farmed under aquaculture, with a corresponding variety of technologies and intensities with huge implications on GHG emissions. Feed for the fish is made from a range of raw materials, which can be sourced from area the farm is located, or from international suppliers including Zambia. The majority of farmers including MALADECO fisheries make local but sinking feed. Chambo fisheries are only making enough floating feed to meet its requirement. During consultations, the farm manager indicated that the number of smallholder farmers demanding the floating feed is very low to venture into commercial production.

73. **Few farmers use floating feed largely because the feed from Zambian suppliers is expensive for SHFs. Consequently, sinking feed is widely utilized because it can locally be sourced and made from local materials.** To prevent feed wastage, some farmers use feed pens which allow fish utilize a large proportion of the feed before sinking. Similarly, farmers who use maize bran to feed fish ensure that the bran is fully dried up such that fish utilizes a large proportion of the feed before sinking. These two methods of feeding achieve efficiency of use on one hand, and on the other hand, reduce the amount of decomposition of sunk feed materials which release GHGs. Chambo Fisheries operate with self-recycling systems designed for ammonium removal. These practices are useful in emission reduction, but they not widely adopted due to limited policy support leading to the absence of financing mechanisms, limited technical skills and lack of supportive extension services. The sector should strengthen extension service delivery while lobbying financial institutions to invest through various arrangements with smallholder farmers, especially women.

CHAPTER 4: CONCLUSIONS AND RECOMMENDATIONS

74. The aquaculture sector is rapidly expanding. The emergence of two private investors including Chambo Farm Limited and MALADECO is a significant development the sector has witnessed. However, smallholder farmers in the country are still grappling to make the aquaculture business viable and attractive. The report has also highlighted some success factors from which lessons can be learnt in terms of the development of a climate smart aquaculture toolkit and a policy brief for the attention of policymakers. Climate change is negatively affecting productivity of the aquaculture sector but adaptation in the sector has not developed deliberate approaches to deal with the challenge. Being semiarid areas, the limited water resources in fishponds hardly take farmers to the next growing season and consequently, fish stocks are harvested before they reach the harvesting stage. While this practice is important in adapting to the impacts of limited rainfall, it reduces profitability of the fish farming business.

75. Some farmers have adapted to the impacts of climate change through (i) an integrated system of crop-livestock-fish. From a climate smart aquaculture approach, these systems serve two purposes. First, they ensure household food and nutrition security, increase productivity of the farms and therefore increase household incomes, besides proving adaptation to floods. Nevertheless, the level of adoption by smallholder farmers is limited due to lack of information, technical support and encouragement (ii) Deeper pond construction. Some farmers construct deeper ponds to access underground water. However, the costs involved in such construction is generally discouraging. Irrigation using boreholes has been also observed which serves the purpose of dealing with limited water supply. Increasing productivity and incomes to achieve one of the pillars of climate smart aquaculture requires exploring and exploiting existing potential partnership between largescale aquaculture farmers and smallholder farmers to unlock barriers to commercialization of the smallholder aquaculture subsector.

76. From a business perspective, CASA notes that business development services for aquaculture SMEs and individual farmers are largely non-existent in Malawi. Most SHFs and SME producers do not have the capacity to develop nor the ability to outsource business strategic documentation such as business plans and sales and distribution strategies to exploit better prices. The Government of Malawi has established a quasi-public institution called the Small and Medium Enterprise Development Institute (SMEDI) to be the leading provider of business development services. Insufficient support to Extension services is a critical challenge among many farmers to promote on job capacity building and application of the much needed knowledge for an economically viability of fish farming. Districts like Salima and Phalombe are hard hit with inadequate extension workers. In

summary, besides the issues raised in previous sections, the CASA strategy identified numerous problems, at all stages of the value chain, that impede the participation of actors in the market system, particularly small-scale players. Of priority include:

(i) Low production volumes to meet market demand

(ii) Use of low-quality inputs by small-scale producers

(iii) Lack of product aggregation arrangements to support viable investment in value addition through processing, distribution and marketing

(iv) Lack of knowledge and skills in fish processing for value addition

(v) Limited access to finance for investment in downstream functions of the value chains.

(vi) Lack of incentives to invest in processing and distribution due to low fish supply by SHFs

4.1 Enhancing Resilience to Climate Change

77. The opportunity to transform the sector through CSA is inherently immense but needs capacity for adoption and upscaling. First, the Ecosystem Approach to Aquaculture (EAA) outlines principles and practices that are central to ensuring the sustainability of the sector. However, adoption of such principles and approaches is not keeping pace with the increasing need for their implementation. While there are traditional adaptation practices, their adoption too is limited by the lack of tools to upscale them for wider and long-term impact. In addition, those responsible for extension delivery are not adequately equipped in knowledge and practice to deal with climate change adaptation and mitigation. The aquaculture industry in Malawi faces is faced with weak extension support for smallholder fishers due to low numbers of qualified government extension workers. Productivity for most smallholder farmers is low, averaging about 1 metric tonne per hectare compared to a potential of 6 tonnes per hectare. This ultimately inhibits the profitability of the sector and holds back commercialisation. Adoption of Climate Smart Aquaculture needs to be supported by demonstrating its potential for profitability to contribute to household incomes. The toolkit will provide a technical guide besides case studies to demonstrate this potential for attraction of investors and vulnerable communities.

78. **Recommendations 1: If the aquaculture sector in Malawi is to adapt through diversification by way of the introduction of alien fish species, the following principles should be complied to[29].**

(i) Diversification demands information. Identify knowledge gaps and seek expert advice.
(ii) Diversification should anticipate, adapt to and mitigate the effects of climate change.
(iii) Diversification should be compatible with local ecosystems and not reduce aquatic biodiversity.
(iv) Diversification should be compatible with other responsible food producing sectors.
(v) Diversification should comply with national and international laws, codes of conduct and conventions.
(vi) Diversification should be planned in consultation with all stakeholders and be attractive to farmers.
(vii) Diversification should minimize risks from pathogens and predators.
(viii) Diversification should be profitable

29 Harvey, B., Soto, D., Carolsfeld, J., Beveridge, M. & Bartley, D.M., eds. 2017. Planning for aquaculture diversification: the importance of climate change and other drivers. FAO Technical Workshop, 23–25 June 2016, FAO Rome. FAO Fisheries and Aquaculture Proceedings No. 47. Rome, FAO. 166 pp.

in domestic and/or export markets, taking account of the risks of market shifts.

79. **Recommendation 2:** The aquaculture sector must respond to the coupled challenges of climate change and environmental degradation while at the same time taking an active role in reducing its own impacts on the environment. The Ecosystem-Based Approach which accounts for broader scale environmental issues should be promoted in the development a climate smart toolkit.

80. **Recommendation 2:** The concept and approach of climate smart aquaculture is relatively new in the aquaculture sector, yet it subsumes the potential to improve adaptation, mitigation and increasing productivity of the fish farms. The department of fisheries and NGOs should promote integrated systems for adaptation of the farming system.

81. **Recommendation 3:** The Policy environment is generally supportive although practices on the ground call for a revisit of the policy on introduction of exotic species. Government should use emerging evidence to reconsider the banned fish species which are preferred for fast growth which will boost the productivity of the industry and further help adapt to climate change.

4.2 Promoting Ecosystem-Based Adaptation Strategy

82. Competing use of the watersheds in fishpond located areas is one of the major challenges which farmers are facing. Fish farmers are often working in isolation from crop-based or livestock-based farmers. Most watersheds are now degraded. The stabilizing mechanisms that would otherwise allow the fishponds to be resilient from both flooding and droughts have been eroded. Autonomous adaptation taking place in high-risk areas will accelerate as climate impacts become more visible and awareness spreads. However, poorly designed government-led planned adaptation projects can, and often do, crowd out autonomous adaptation measures such as self-protection or self-insurance. Nevertheless, autonomous adaptation can be too expensive in economic activities with low profit margins, so public investments which reduce adaptation costs are necessary.

83. **Recommendation 1:** Create an enabling environment for autonomous adaptation through strong social capital, effective community-based organizations, strong collaboration and coordination of a wide range of diverse interest groups.

84. **Recommendation 2:** Promote investment in ecosystem rehabilitation, repair and development in watershed areas for long-term sustainability of the different farming systems

4.3 Improving Business Enabling Environment

Recommendation 1: Aquaculture as a business suffers from low investment in the sector. Smallholder farmers lack business development services and extension services to promote their business skills. As the Climate Smart aquaculture toolkit is developed these areas are critically important to consider.

Recommendation 2: Fish farms individually owned by women are few, this is largely due to the high labour requirements and costs associated with the construction of fishponds. The group owned fish farms, however, accommodate women but these farms are poorly performing. Financial support is required if women are to meaningfully participate in aquaculture development.

Recommendation 3: As the aquaculture industry expands, climate smart aquaculture offers an opportunity for policymakers to collaborate with investors. Furthermore, there is a need for cooperation between different government departments (including business/industry, finance and environment) so that no new unintended policy barriers are created and – like the business solution – the policy response is designed to maximize system effectiveness. Other society stakeholders, including citizens and consumers, labour unions and environmental organizations, should also be engaged. Investors need to be guided in adaptation and environmental, and climate change mitigation measures.

Recommendation 4: Lack of better performing indigenous fish species is integral to the barriers to efforts to increase the aquaculture productivity in the country. Prevailing rules and regulations prevent the introduction of exotic fast-growing species with higher weight. Government should initiate a revisit of the ban on exotic species which has recently become an issue of public debate. A comprehensive and integrated risk assessment of the likelihood impact is required before lifing the ban.

Recommendation 5: The Department of Fisheries should facilitate collaborative arrangements between large scale private companies such as Chambo Fisheries Limited and MADECO, with smallholder farmers to accelerate the sector development.

4.4 Enhancing Mitigation Potential of the Aquaculture Sector

The literature review established that aquaculture activities make a minor but still significant contribution to greenhouse gas (GHG) emissions during production operations and the transport, processing and storage of fish[30]. There are significant differences in the emissions associated with the sub-sectors and with the species targeted or cultured. The use of sinking feed threatens the environmental sustainability of the aquaculture industry as the decomposing feed releases GHGs.

4.5 Increasing productivity and household incomes

Recommendation 1: Lack of better performing indigenous fish species is integral to the barriers to efforts to increase the aquaculture productivity in the country. Prevailing rules and regulations prevent the introduction of exotic species fast growing with higher weight. Government should initiate a revisit of the ban on exotic species which has recently become an issue of public debate. A comprehensive and integrated risk assessment of likelihood impact is required.

Recommendation 2: Fish-crop-livestock integrated farming is the most striking feature of farming observed in the field but practised among few farmers and this can have considerable significance in raising productivity of the farming systems. Based on the field observation, appropriate forms of integration and motivation and feasible systems of management suitable to different districts have to be developed through pilot operations. It is recommended that at least the climate smart aquaculture toolkit will capture variations of the different forms of integration to inform implementation of pilot projects in suitable areas to test the feasibility of such integrated farming and to evaluate the extent and

30 **FAO (2009).** Climate change implications for fisheries and aquaculture Overview of current scientific knowledge. FAO fisheries and aquaculture technical paper. 530 Rome

nature of benefits that would accrue under different conditions.

Recommendation 3: Promote transition to new species that adapt to the changing climatic conditions, fast growing in local aquaculture situation on locally produced feed; processed/ preserved using green energy; in demand on the local market and environmentally safe.

Recommendation 4: Develop an insurance mechanism for aquaculture, as it could protect smallholder fishers against production and climate risks.

4.6 Gender mainstreaming in Aquaculture

Almost all development policies recognize the crucial role gender plays in influencing interventions in poverty reduction, food and nutrition security and climate and environmental changes the country is undergoing. However, practice in the aquaculture sector can be strengthened through the CSA approach. Recommendations to do so include:

Recommendation 1: Climate Smart Aquaculture can achieve its goals when it fully incorporates women and marginalized groups into program design and implementation. Men, women, and children all play a role in maintaining healthy aquaculture enterprises. For this reason, it is important that both genders be considered and consulted within the CSA toolkit in all matters of planning and decision-making processes.

Recommendation 2: Mainstream gender concerns and empower women to contribute to adaptation and mitigation efforts, building on an understanding of the different capacities and vulnerabilities of men and women. Actions could include strengthening women's leadership in fishery organizations, ensuring that new sectoral legislation and budgets reflect women's concerns, and providing women with financial and technical skills, and access to weather and environmental information.

4.7 Capacity-building and research

Recommendation 1: The aquaculture sector should develop capacity and promote the use of scenario-building methodologies to enable policymakers to identify key features of aquaculture production, as well as the drivers of change, and to understand vulnerability to climate change and climate variability. This helps to create responsive planning scenarios and design evidence-based and coherent adaptation policies and plans at all levels.

Recommendation 2: Strengthen the knowledge base and climate change advisory capacity of fisheries and aquaculture extension workers and revise extension training material to take into consideration the effects of climate change. Such services will play a crucial role in disseminating knowledge in remote fishing and aquaculture communities. Well-trained extension workers and extension material incorporating climate risks will be key.

Recommendation 3: Strengthen the capacity of relevant agencies and authorities to monitor and disseminate information on occurrence of disease in fish farms and harmful algal blooms, including red tides and ciguatera, which may increase due to climate change, especially in areas known to be vulnerable to eutrophication (De Silvaand Soto 2009).

Recommendation 4: Promote innovation, research and technology development: adapt to changing

environmental conditions by developing new strains of aquaculture species tolerant to low water quality and high temperatures, and resistant to disease, while enhancing disease control systems in aquaculture.

4.8 Proposed Financing Models

113. **Aquaculture farmers often lack access to financial services for their capital expenditures and working capital**. Improving availability of credit and saving products to enable financing of SHFs will remain a major option for mitigation and adaptation to climate change. Credit system will require appropriate financial institutions, better understanding of the sectors and building capacity to reduce risk. Saving and credit groups are alternatives to formal financial institutions. Banks in the country often have limited understanding of the aquaculture sector and find it hard to identify bankable opportunities. Borrowing from the Indonesian experience, we propose three possible solutions: to share risks along the value chain; to provide credits after the breakeven point and to use crowdfunding. The following are major recommendations to realize these solutions:

Recommendation 1: Promote a risk-sharing model by addressing risks and risk mitigation from multiple players, protecting the lender, the company, or the bank. Sharing the risk along multiple actors in the value chain reduces the risks in two ways (i) the costs are shared along the value chain; (ii) if multiple parties play a role in the arrangement, the risks themselves are reduced because the value-chain players are better connected, and collaboration is increased. An example of this model is a risk-sharing agreement between an international financial institution, a local bank, a public organization, donors, a large-scale company, farmers, and/or a farmer cooperative. The company develops a supply chain structure in which the company provides services such as training, access to inputs and information for farmers to increase their productivity. Local banks finance and disburse the loan. Local banks can also share the risk on the portfolio with the large-scale company and buy the loan portfolio to keep the program running.

114. A related example of risk-sharing model is financing smallholder farmers through the input supplier. Banks interested in financing smallholders can extend their service through lending directly to the seed or feed supplier but allowing them to give a provision of credit to individual farmers. Banks thereby increase their benefit because they only lend to trusted parties by outsourcing the lending decision to the input suppliers who assess the farmer's track record, capacity and commitment. This arrangement ensures that quality inputs reach farmers, hence reducing their production risks. The Chambo Fisheries expressed intentions to enter into similar arrangements, but this needs guidelines for mutual benefits.

115. Policymakers are better placed to address market and regulatory failures to create the right enabling conditions towards the transition to climate smart aquaculture. This synthesis report primarily informs the development of Climate Smart Aquaculture toolkit which will guide future investment in, or financing of, aquaculture development for increased adaptation, mitigation and increased productivity and incomes. The aim is to support building resilience of smallholder farmers and investors from the impacts of climate change which will not only lead to accelerated growth but also sustainable growth of the sector. The report is prepared for policymakers and investors operating in the aquaculture subsector country.

It aims to provide a summary of the aquaculture sector and its potential for investment, a description of the climate change risks and mitigation and adaptation strategies, and a presentation of possible financial arrangements the country can consider supporting SMEs.

Recommendation: Increase availability of credit and saving products to enable financing of adaptation. Credit systems will require appropriate financial institutions, better understanding of the sectors and building capacity to reduce risk. Saving and credit groups are alternatives to formal financial institutions.

Annexes

Annex 1 - List of Stakeholders consulted.

SR	NAME	DISTRICT
	The Director, Fisheries Department	Lilongwe
	Mzuzu Fish Center	Mzuzu
	Dr. Sikawa, Lilongwe University Agriculture and Natural Resources, Aquaculture and Fisheries Department	Lilongwe
	Mr Mwangonde	Mzuzu
	Mr Kaunda	Chaluluma village, Mzuzu
	Mrs L. Chavula	Mzuzu
	Mr Mkandawa –Fisheries Dept Officer	Rumphi
	Mr Cyrus Msiska – (Mubunju Epa)	Rumphi
	Umodzi Fish Farming Group	Rumphi
	Mtambo Family Fish Farming Group	Chitipa
	Chimangw'ali Group Fish Farming Group	Karonga
	Chimmwemwe Club Fish Farming Group	Balaka
	Chambo Fisheries	Blantyre
	Talandira Fish Farming Group	Phalombe
	DFO -Balaka District Fisheries Officer's	Balaka
	Mkwawa Farmers Club	Mangochi
	Maldeco	Mangochi
	Champiti Fish Investment	Salima
	Mr Lameck Gomezga	Salima

Annex 2 – Details of data collected for the computation of profitability of the aquaculture fishpond in Mzimba

PRODUCTION	
Estimated pond area (m^2)	3,900
Quantity of table-size fish harvested (tons)	1.2
Table-size fish market price (MK/Kg)	2,500
Age of fish at harvest (Months)	8
Gross Revenue (MK)	**3,000,000**
FIXED COSTS (FC)	
Value of land (Mk)	500,000
Pond-construction labour charges (Mk)	150,000
Other fixed assets used, specify (e.g. pond maintenance, fish harvesting gear)	
Total Fixed Costs	**650,000**
VARIABLE COSTS	
Cost of fingerlings (MK)	78,000
Feed	
Floating feed (Mk)	1,200,000
Maize bran	8,000
Labour (MK)	720,000
Fertiliser (Mk)	180,000
Manure (Mk)	8,000
Marketing costs (advertising and transportation)	10,000
Total Variable Costs	**2,204,000**
Gross Margin (GR-TVC)	796,000
Net Income (GR-TVC-TFC)	146,000

ANNEX 3: Terms of Reference

DEVELOPMENT OF A TOOLKIT FOR CLIMATE SMART AQUACULTURE IN MALAWI

Vacancy Type: External

Location: Malawi (Lilongwe)

Application Deadline: 11th November 2019

Category: Environment and Sustainable Development (ESD)

Type of contract: Short Term Individual Consultant (National)

Reporting Language: English

Starting Date: 25th November 2019

Expected Duration of Assignment: 30-person days (Spread over 3 calendar months)

Project Title: Poverty-Environment Action for the SDGs

About Poverty-Environment Action for SDGs – Malawi

The Poverty-Environment Action for Sustainable Development Goals (Poverty-Environment Action) is a joint UNDP-UN Environment initiative that seeks to deliver technical advice, advocacy and knowledge products for supporting the Government of Malawi in the implementation of core government businesses, policies and plans in the environment, natural resources (ENR) and related sectors. In Malawi, UNDP has partnered with FAO and UN Women in the delivery of this initiative. The Project seeks to foster integration of environmental sustainability and climate objectives in development planning, budgeting and monitoring systems; and incentivize shift in public and private investments towards environmental sustainability and climate objectives for poverty eradication. The Project focuses on leveraging agricultural production and gender equality to build resilience of households to shocks and to address food security and poverty alleviation through the sustainable management of the environment and natural resources. Implementation is spearheaded by the Department of Economic Planning and Development (EPD) in the Ministry of Economic Planning and Development (MoFEPD), which is Malawi Government's main planning agency responsible for national economic and development planning and monitoring and evaluation of socio-economic issues in the country.

BACKGROUND AND RATIONALE

Fisheries and aquaculture provide essential nutrition, support livelihoods and contribute to national development in Malawi. Fish provides over 70 per cent of the dietary animal protein intake of Malawians and 40 per cent of the total protein supply. It also provides vital vitamins, minerals and micronutrients[31]. Much of the fish is consumed in rural areas thereby contributing significantly to daily nutritional requirements to some of the vulnerable groups such as HIV and AIDS victims, orphans and the poor (Economic Report 2011). Fishing is the main source of livelihood to 37,089 out of 3,984,981 households in Malawi (NSO, 2018). The sector directly employs nearly 59,873 fishers and indirectly over 500,000 people who are involved in fish

31 Njaya F. (2018): Ecosystem approach to fisheries in southern Lake Malawi: Status of the fisheries co-management

processing, fish marketing, boat building and engine repair. Furthermore, nearly 1.6 million people in lakeshore communities derive their livelihood from the fishing industry. The main provision of the fishery resource comes from capture fisheries. Sustainable fisheries contributes 3 percent to the national GDP, and government has set a target of 3.8% to be achieved by 2022 in partial fulfilment of MGDS Key Priority Area 1: *To achieve sustainable agricultural transformation that is adaptive to Climate Change* (GoM, 2017).

However, the sector is facing significant challenges in maintaining its crucial contribution to these areas. Population pressure on land has resulted in environmental degradation that has consequently reduced benefits that the population derives from the environment (ecosystem services) as shown by reduced stream flows, and decline or extinction of fish, among other challenges (GoM, 2017). Malawi is an agrarian-based economy which largely depends on its abundant environment and natural resources for economic development. More than half of its population live in extreme poverty and experience food insecurity in at least one month of the year, mostly relying on forest-based natural resources raw materials for biomass energy and income[32]. The deforestation rate in Malawi is one of the highest in Africa at 35% and this has contributed to prolonged dry spells, severe droughts and floods, putting a lot of pressure on the country's few natural resources. Fish used to be the most affordable source of animal protein in Malawi up to the early 1990s, but rising costs, overfishing, decreasing supply, increasing population and increasing fish exports have reduced domestic per capita fish consumption from 9.4 kg to 4.9 kg per annum between 1990 and 2011. In terms of protein supply from freshwater fish, statistics show that this has dropped from 2.34 grams to 1.4 grams per capita per day.

The challenges in the fisheries industry have been compounded by climate change that has greatly affected the freshwater ecosystem resulting in decline in fish catches especially for *Oreochromis karongae* (locally known as Chambo) which is regarded as 'the nations pride' as it is endemic to lake Malawi. Estimates show that Chambo catches have declined from 5000 metric tonnes per year in 1980s to less than 3000 metric tonnes per year at present in 2017[33]. Malawi as among the top 15 countries most vulnerable to climate change[34]. Additional challenges confronting the fisheries sector in Malawi include declining stocks due to over□ fishing in shallow waters, weak institutions for the enforcement of regulations, and a significant decline in fish catches from Lake Chilwa from as high as 10,186 tonnes in 1994 to 1,069 tonnes in 1997 due to the desiccation of the Lake because of persistent drought episodes (Yaron et al, 2011; Van Zalinge *et al.*1992). Given that most farmers in the country are smallholders with less than 1 ha of rain-fed land and given the increased incidence of drought and flooding in the country, climate change is increasingly having a substantial adverse impact on the productivity and output of most farmers.

Environment and natural resource degradation have both macro and micro –level impacts. At the macro- level, unsustainable natural resource use is estimated to cost the country 5.3% of GDP every year reducing economic growth and frustrating poverty reduction efforts (Yaron, et al., 2011). With respect to poverty rates, in 2010, Malawi's poverty headcount ratio at the national poverty line was 50.7 % while a more inclusive Multidimensional Poverty Index indicated a poverty rate of 66.7 % for the same year (Oxford Poverty and Human Development Initiative, 2013[35]. The decline in fish catches has significantly affected the economic well-being of more than 200,000 people who are directly involved in the industry through fishing and indirectly through fish processing, marketing and trading. Presently, fish catches in Malawi are targeting low valued fish species such as *Eungalycyprinus sardella* (Usipa) because most of the high valued fish species such as Chambo, which are mostly found in shallow waters of lake

32 2016 World Bank report

33 FAO (2017). The state of food and agriculture: Leveraging food systems for inclusive rural transformation. FAO, Rome.

34 2018 Government of Malawi Annual Economic Report

35 Overcoming Poverty in Malawi through Sustainable Pathways: Identifying Policy Options to Accelerate Poverty Reduction by Quantifying Poverty and Environment Linkages

Malawi are close to extinction. The decline in fish catches has also influenced the per capita fish consumption, which is currently at 12.47 kg/capita/year against the most recent data of average world fish consumption which is above 20kg/ capita/ year in 2014 and is expected to grow further in the coming decade. Besides GDP growth implications, as it has been witnessed in early 2015, environment and natural resource degradation in form of deforestation increases both the risk and severity of soil erosion and flooding that results in siltation and ultimate destruction of fish breeding grounds while affecting other parts and elements of the aquatic system.

Dwindling fisheries productivity is a growing development concern in Malawi. As such, promoting and encouraging sustainable fisheries management and commercial aquaculture development are among the key strategies for agricultural diversification in Malawi. The Government of Malawi in its efforts to address the decline in catches has made efforts to develop aquaculture, in line with the Malawi Growth and Development Strategy (MGDS III), the National Agriculture Policy, the National Agriculture Investment Plan (NAIP), the National Resilience Strategy (NRS) (GoM, 2017) and the National Fisheries and Aquaculture Policy (NFAP) of 2016. The National Fisheries and Aquaculture Policy advances that despite the several constraints affecting the aquaculture development, the sector has great potential for growth which can have a significant contribution to the economy of the country. It challenges that by targeting large scale operations and promoting aquaculture as business at various operational levels (small, medium or large), fish supply will increase resulting in increased financial returns. Supportively, the broader National Agriculture Policy seeks to facilitate timely and equitable access for farmers to high quality fish fingerlings as one way of promoting sustainable agricultural production and productivity. It encourages farmers to diversify production of crops, livestock, and fish in order to enhance availability of nutritious food products as one way of ensuring availability and access to safe and nutritious food products in sufficient quantities (GoM, 2017). Similarly, the NRS seeks to promote resilient agriculture growth. It seeks to incentivise both estates and smallholder farmers to diversify and engage in in fisheries production (among other investments) through policy reforms to create an enabling environment, in line with the New Alliance for Food Security and Nutrition policy commitments of the Government of Malawi (GoM, 2017). The NRS also promotes sustainable aquaculture production. It propagates the strengthening of asset creation and dietary diversification for smallholder production systems, value addition for diversified farm production and value addition with the goal of increasing supply both to domestic and export markets (GoM, 2017).

To achieve the desired food security and national fisheries development goal in the face of population growth, environmental degradation and climate change, the adoption of climate smart aquaculture which is an adaptation to climate change will be necessary. The growing interest in aquaculture investment provides an impetus to sustained fish production for local and export markets (GoM, 2016). With increased fish production from both capture fisheries and aquaculture coupled with value added initiatives, it is expected that fish exports will also increase by focusing on targeted markets that will include both high and low value fish products mainly destined for the regional market (GoM, 2016). The aquaculture sub-sector has potential to increase fish production in the country. Enhanced aquaculture production especially at commercial level would improve supply of fish protein in rural areas far away from the major fish production sources and creation of wealth and employment in such areas. The aquaculture subsector can also be one of the major sources of fish product exports, thereby contributing to Malawi's economic growth. There are 6,000 fish farmers with varying sizes of ponds in the aquaculture subsector. Fish production in the sub-sector has been increasing from an estimated 800 tonnes per annum in 2006 to 3,600 tonnes per annum by 2015. However, one of the major problems identified with commercial aquaculture is that the species cultured are slow growing and have a poor feed conversion, making the products of aquaculture expensive to produce (GoM, 2016).

Climate smart adaptation and mitigation strategies have helped to increase the resilience and adaptive capacity of communities and ecosystems in other parts of Africa such as in the Niger

- Delta region of Nigeria where about 80% of fish farmers were reported to have adopted strategies including the use of tarpaulin/tank ponds during dry weathers, about 70% have adapted by adjusting time of stocking while 60% stocked fish species that can better adapted to climate change impacts (Olawale & Oluniyi, 2016). It is therefore expected that Climate smart aquaculture will help Malawi to respond to climate change by boosting adaptive capacity and resilience both of communities and the ecosystems on which they depend. The adoption of context specific climate change adaptation and mitigation strategies is expected to safeguard sustainable fish production and food security improvement in the country.

The FAO has provided considerable guidance on the application of climate smart approaches in the aquaculture sector. The Code of Conduct for Responsible Fisheries and the ecosystem approach to fisheries and aquaculture outline the principles and approaches that are central to ensuring the sustainability of the sector. However, these guidelines are generic, and the application of the core principles and approaches is not keeping pace with the increasing need for their implementation. While the general understanding of the implications of climate variability and change is improving, information on local-level impacts and vulnerabilities is lacking, which hampers context-specific adaptation planning[36].

Against this background, the Department of Fisheries in the Ministry of Natural Resources, Energy and Mining in collaboration with UNDP in Malawi seeks to develop a toolkit on Climate Smart Aquaculture that should provide practical solutions and steps to addressing prevalent and emerging aquaculture development issues of the fisheries sector, linked with cross-cutting issues from other sectors as they affect or interact with the fisheries sector. It is expected that the toolkit will also give clear directions in terms of priority actions and steps that Government and its partners, including the private sector must take to mobilize and catalyse financing and investment in climate smart aquaculture options for accelerating growth and development of the sector whilst making the best use of available resources in the context of limited human resource, finance and logistics.

The development of the toolkit takes cognisance that the transition to CSA needs to take place at all levels (individual, business, community, national and regional) and time scales. All stakeholders from private and public sectors will need to be involved in the development of context-specific options to ensure the aquaculture sector is climate-smart. It is therefore expected that the toolkit will be premised on a detailed understanding of the effects of markets and trade on production that may affect food security, consumer prices and supply-demand gaps and the implications of climate change impacts and climate change policies on the entire supply and value chain.

This activity is commissioned under the framework of the joint UNEP-UNDP supported Poverty-Environment Action for Sustainable Development Goals Project that seeks to advance the integration of environmental sustainability and climate objectives in development planning, budgeting and monitoring systems; and advocate that public finance and investment frameworks incentivize shift in public and private investments towards environmental sustainability and climate objectives for poverty eradication. This initiative responds to SDG1 that seeks to end poverty in all dimensions, SDG2 that calls upon nations to end hunger and SDG 15 that advances strategies for sustaining life on land. The toolkit will aim at incentivizing the shift in programming, financing and investments in the aquaculture sector towards achieving food security and improving nutrition whilst promoting sustainable agriculture that addresses gender and environmental challenges to reducing poverty.

Objectives of the Assignment

The objective of this assignment is to develop a toolkit for climate smart aquaculture to take into consideration the current and future aquaculture landscape in terms of species cultured and the prospects for sustainable production and consumption. There is also the need to have

36 FAO Climate Smart Fisheries and Aquaculture Guidelines Module 10

an inclusive approach that takes into consideration gender issues along the value chain of the industry particularly with regards to processing and marketing. The toolkit will in its entirety provide information on sustainable aquaculture production focussing on the main components of an aquaculture enterprise and the key decision-making process, in compliance with national policies on fisheries that can leverage private sector investment in sustainable aquaculture production. It should highlight factors for commercialization and for profitable aquaculture that can attract investment in the sector to increase the contribution of the sector to the overall national economy and to promote the ability of households to meet their nutrient and daily caloric requirements for a healthy and productive lifestyle.

The toolkit should address the following requirements:

i. Respond to considerable increases in national and global demand for aquatic food in the face of climate change and other drivers, and to satisfy specific issues of food access and livelihoods, across the complete supply, value and benefit chains;

ii. Identify specific areas for value addition along the value chain of the industry with the view identifying in concrete terms activities that incorporate women and the youth and help create jobs and thus improve the economic empowerment of women and youth in the industry;

iii. Demonstrate in concrete terms the profitability prospects of a typical aquaculture enterprise and through simulation of data and information show the possible pathways for increasing profitability in the firm both in the short and in the long run;

iv. Identify specific gaps in capacity, efficiency, and system resilience evident in current conditions for the sector, and particularly those which are potentially likely to increase under climate stress; and to identify generic or specific actions to address these threats and ensure the sustainable growth of the fishery sub-sector in the country;

v. Address options for better integration within and across the sector, spatially, in terms of function and flows of goods and services, and in efficiency of resource use and resilience of function;

vi. Connect effectively and coherently with related development objectives, such as hunger eradication, poverty alleviation, resource protection and rehabilitation, nutritional safety and health, personal and community empowerment, self-determination and vulnerability reduction; and

vii. Be clearly recognisable and actionable by policy agents, working effectively with practitioners and beneficiaries at all levels, based on clear evidence of functionality and effectiveness.

SCOPE OF SERVICE

Coverage

The toolkit shall be used as a response to Ecosystem-based Approach to Fisheries and Aquaculture, making use of the synergies and trade-offs which exist between SDGs 14 and 15.

Tasks

This assignment integrates literature review, consultations, holistic thinking, assessments, analyses, mapping exercises. Consultations shall be held with national and district level personnel in targeted sectors as determined by the consultant in agreement with the Client. The Client shall provide a list of key personnel and their contacts details (telephone and e-mail addresses) for this purpose.

The specific tasks are, but not limited to, the following:

Preparation

i. Prepare and submit to the Task Team a draft inception report articulating the objects of the exercise, proposed methodology, study tools and timeframe; and

ii. Revise the draft inception report to incorporate inputs from the Client and stakeholders. Next steps will only be undertaken upon approval of the inception report.

Data Collection and Analysis

i. Review literature including existing policies, laws, regulations, guidelines and any other documentation that may be of relevance to this assignment;

ii. Hold consultations with key informants and relevant stakeholders to understand the nature and scope of the assignment in detail;

iii. Conduct baseline assessment of existing aquaculture architecture in the country including promoting and frustrating elements for improved planning, monitoring and evaluation, and promoting financing and shifting investments for accelerating growth of the sector; and

iv. Analyse causes and effects of prevailing aquaculture development and management practices and conditions and propose measures for improving the situation.

Toolkit Development

v. Isolate key messages from the synthesis report and develop a draft toolkit with guidelines and steps for advancing Climate Smart Aquaculture in Malawi in ways that demonstrate a business stance to the enterprise for reducing poverty and achievement of the sustainable development goals;

vi. Include in the toolkit priority measures to be undertaken in the short to medium term;

vii. Facilitate a workshop with participates to review the draft toolkit and solicit input; and

viii. Revise the draft toolkit to incorporate Client and stakeholder input.

METHODOLOGY

The consultant shall apply a combination of contemporary and participatory tools and methodologies (such as systematic literature review, key informant interviews, and focus group discussions) to obtain the best possible data, analysis, results and interpretation of results from this study. The methodology should include but not limited to the following:

i. Review literature including existing relevant policies, regulations, guidelines, project documents, and any other documents to get a detailed understanding of the aquaculture architecture as it relates to Malawi and other parts of the world;

ii. Hold consultations with key informants and relevant stakeholders to understand the nature and scope of the assignment in detail. Consultations should be held with, but not limited to Fisheries Department, members of the Local councils, Development Partners and farmers. Use these meetings to raise awareness about the necessity of the toolkit and the processes to be followed;

iii. Use appropriate qualitative and quantitative approaches to conduct baseline assessment of existing aquaculture resources and aquaculture development

methodologies in the public and private sectors including challenges and opportunities for improvement;

iv. Use appropriate tools and methods to analyse the causes and effects of prevailing aquaculture development and management practices and suggest measures for improving the planning, monitoring and evaluation of the sector, and for incentivising financing and accelerating growth of the sector within the constraints of limited financing, low technological advances and climate change, among others; and

v. Use data and insights from the study to develop a toolkit with practical measures and steps for incentivizing the shift in programming, financing and investments in the aquaculture sector towards achieving food security and improving nutrition whilst promoting sustainable agriculture that addresses gender and environmental challenges to reducing poverty.

EXPECTED OUTPUTS AND DELIVERABLES

The main output of this assignment is the **toolkit for Climate Smart Aquaculture outlining** guidelines for improving the planning, implementation and monitoring and evaluation of aquaculture development, and incentivizing financing and investment in aquaculture whilst addressing the poverty reduction and resilience needs of men, women and other marginalized groups. Other deliverables are as follows:

i. *Inception report* complete with detailed methodology, data collection tools, updated work schedule/timelines and proposed format for the toolkit and synthesis report;

ii. *Draft synthesis Report* elaborating the key issues in the aquaculture sector and proposed measures for addressing them;

iii. *Draft Climate Smart Aquaculture Toolkit* complete with key issues and steps/guidelines for advancing the core elements of accelerating financing and investment, improving delivery and benefits realization from the sector.

iv. Facilitation of a *consultative workshop* where the draft synthesis report and draft CSA Toolkit shall be presented to stakeholders for review and input. The Toolkit shall include an action plan clearly indication short – medium term measures that need to be undertaken in addressing priority concerns.

v. *Revised synthesis Report* elaborating the toolkit development process, key frustrating and promoting factors of the aquaculture sector in Malawi, and proposed measures for accelerating growth (including in terms of financing and investments), benefits realization and sustainability.

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