Food and Agriculture Organization of the United Nations

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**Poverty-Environment Action**
*for Sustainable Development Goals*

# CLIMATE-SMART AQUACULTURE

## A Toolkit for Policymakers and Investors

# 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.

It is now time to invest in aquaculture. 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 this call for guiding the transformation of the aquaculture sector.

The transformation is particularly needed to satisfy the growing demand for quality animal proteins in the country and contribute to poverty reduction among the most vulnerable groups – 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 for investors to move towards the transition to climate smart aquaculture. This toolkit primarily guides the delivery of Climate Smart Aquaculture for current and 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 the resilience of smallholder farmers and investors from the impacts of climate change and related risks which will not only lead to accelerated growth but also sustainable growth.

With the vast number of possibilities for creating value out of the Climate Smart Aquaculture, and cradle-to-cradle thinking, it can be challenging to assess all the options. The CSA toolkit has consolidated all the opportunities and provided information on how investment could over time start finding benefits. Read through the toolkit. Use it to create more valuable and sustainable aquaculture products and services for the good of the country.

# ACKNOWLEDGEMENTS

The Ministry expresses sincere gratitude to all those that took part in the development of the Climate Smart aquaculture toolkit. Mrs. Etta M'mangisa, the Program Analyst, and her entire team of the UNDP including Linda Chinangwa, the Project Manager-PEA who in collaboration with UNEP and FAO gave the necessary support to produce the toolkit, funding and coordination of the process. The development of this toolkit benefited from the immense experience of Dr. James Mbata, the International Technical Advisor, UNDP Malawi. Dr. John Kazembe, the Consultant provided leadership in the preparation of the document through the engagement of various stakeholders from relevant ministries. All those consulted are recognized for their time, technical input, information and all forms of support given to the Consultant. This is their product for use and benefit.

# GLOSSARY

**Aquaculture:** Aquaculture is an industrial process of raising aquatic organisms up to final commercial production within properly partitioned aquatic areas, controlling the environmental factors and administering the life history of the organism positively and it has to be considered as an independent industry from the fisheries.

**Ecosystem Approach to aquaculture:** An ecosystem approach to aquaculture (EAA) is a strategy for the integration of the activity within the wider ecosystem such that it promotes sustainable development, equity, and resilience of interlinked social-ecological systems.

**Climate Change Adaptation:** Adaptation (to climate change): Adjustments to current or expected climate variability and changing average climate conditions. This can serve to moderate harm and exploit beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation.

**Climate Change Mitigation:** Technological change and substitution that reduces resource inputs and emissions per unit of output. Although several social, economic and technological policies would produce an emission reduction, with respect to climate change, mitigation means implementing policies to reduce GHG emissions and enhance sinks.

**Climate Change: Climate change:** Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forces, or to persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that the Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods'. The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes.

**Climate smart Agriculture:** Agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes greenhouse gases (mitigation), and enhances the achievement of national food security and development goals.

**Climate Smart Aquaculture:** Aquaculture that sustainably increases productivity, resilience (adaptation), reduces/removes greenhouse gases (mitigation), and enhances the achievement of national food security and development goals.

**Climate variability:** Variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all temporal and spatial scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability)

**Ecosystem resilience:** The capacity of an ecosystem to absorb external pressure or perturbations through change and re-organization, but still retain the same basic structure and ways of functioning.

**Ecosystem**: The interactive system formed from all living organisms and their abiotic (physical and chemical) environment within a given area. Ecosystems cover a hierarchy of spatial scales and can comprise the entire globe, biomes at the continental scale or small, well-circumscribed systems such as a small pond.

**Externalities:** Situations when the effect of production or consumption of goods and services imposes costs or benefits on others which are not reflected in the prices charged for the goods and services being provided.

**Greenhouse gases:** Those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere, and clouds. This property causes the greenhouse effect. Water vapor (H2O), carbon dioxide (CO2), nitrous oxide (N2O) methane (CH4), and ozone (O3) are the primary greenhouse gases in the Earth's atmosphere. Moreover, there are a number of entirely human-made greenhouse gases in the atmosphere, such as the halocarbons and other chlorine and bromine-containing substances, dealt with under the Montreal Protocol. Besides $CO_2$, $N_2O$, and CH4, the Kyoto Protocol deals with the greenhouse gases sulfur hexafluoride ($SF_6$), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs).

**Resilience:** The ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner.

**Sustainability (Economic):** A situation whereby: (1) the value added resulting from upgrading in the value chain (additional profits, wages, taxes, consumer value) is positive for each stakeholder in the extended value chain whose behaviour (in terms of upgrading) is expected to change in order to create the additional value; and (2) the generation of added value sets in motion, or speeds up, a process of growth and structural transformation.

**Sustainability (Environmental):** Meeting the needs of the present without compromising the ability of future generations to meet their needs.

**Social acceptability/social license**: Refers to the degree to which aquaculture is accepted by local and neighbouring communities, the various interest groups and society.

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# ABOUT THIS TOOLKIT

The Government of Malawi is committed to reducing poverty and ensuring food security among the most vulnerable in the society while at the same time ensuring that the environment which provides the base for production is protected from unsustainable production practices. Aquaculture has recently become one of the sectors of investment to achieve the goals of food security and poverty reduction attracting mostly smallholder farmers who have limited investment capacity.

Smallholder fishers are continuously facing risks such as climate change, lack of access to credit, and lack of quality feed and fingerlings to increase the productivity of their enterprises. The National Fisheries and Aquaculture policy is comprehensively supportive of the investment environment but requires operational guide to ensure adaptation and resilience of the farming systems, mitigation to reduce greenhouse gas (GHG) emissions from the sector and increasing productivity and incomes among smallholder farmers to significantly contribute to poverty reduction.

The CSA Toolkit aligns with the CASA strategy and seeks 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 attracting more investment into these businesses. The CASA strategy is an important initiative from which the toolkit will provide synergies for sustainability.

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.

The toolkit has been developed through a consultative process complementary with rigorous synthesis of both grey and published literature. A broad range of stakeholders (Appendix 1) with interests in aquaculture investment has been engaged to provide their perspectives about the nature and scope of the toolkit. They were consulted at three different levels including - policymaking level, technical and field levels. Smallholder farmers and the general public have different interests altogether. These have been consulted to accommodate their interests as well.

Recently, DFID has launched a five-year, flagship Commercial Agriculture for Smallholders and Agribusiness (CASA) programme which seeks to change how investors, donors and government view and invest in agribusinesses that work with smallholder supply chains in the country.

### Purpose and Objectives

The purpose of this toolkit is to provide potential and existing investors in aquaculture with guidance to achieve climate smart aquaculture for poverty reduction and food security and achieve impact at scale in national economic growth. This toolkit has been developed with objectives to:

(a) Foster a greater understanding of investment portfolios in the aquaculture subsector and use Climate Smart Aquaculture approach for adaptation, mitigation and increasing productivity of the investment.

(b) Provide policymakers and investors with the tools to support environmental, social and economic sustainability for the benefit of the most vulnerable including women, children and those with disabilities.

### Target Groups

The nature of the themes addressed in the toolkit renders a wider application in the fields of aquaculture investment, environment and natural resources management. However, CSA practices call for the engagement of many stakeholders. The toolkit, therefore, targets the following categories of participants:

(a) Large scale investors, policymakers and smallholder farmers

(b) Environmental, and natural resources managers and land and water resources managers.

(c) NGOs in rural and community development.

(d) Women and children to benefit from the transformation of the sector.

**Scope and Content**

**Chapter 1. Introduction.** The objective of this chapter is to provide the broader contests of the aquaculture sector and motivate both smallholder farmers and the private sector to consider investment given the pervasive market at global and local level. The chapter discusses how aquaculture might contribute to important policy objectives such as generating economic growth, creating jobs, reducing virgin resource consumption, and reducing carbon emissions. There is also a discussion of the potential role of policymakers in the transformation of the aquaculture to climate smart aquaculture which aims to achieve triple objectives of mitigation, adaptation and increasing productivity for incomes among the poor.

**Chapter 2. Aquaculture Investment Risks.** The chapter provides an overview of the risks associated with aquaculture investments. This is a guide for investors who want to design a strategy to manage the transition towards climate smart aquaculture. It offers a detailed range of risks to explore and prioritise practical opportunities of CSA provided in the case study chapter.

**Chapter 3. Tools for Sustainability**. The chapter orients investors to important regulatory instruments and guidelines that ensure the sustainability of the aquaculture investment. It is a useful guide for both policymakers and investors.

**Chapter 4. Promising Financial models**. One of the challenges smallholder farmers have, relate to access to financial services. This chapter provides various options through which investors and farmers can mutually benefit. The chapter demonstrates case studies of financial models implemented in some countries in Africa.

**Chapter 5. Climate Smart Aquaculture Solutions.** Given the risks associated with aquaculture investments, this chapter demonstrates how CSA can be utilized to mitigate them.

**Chapter 6. Climate Smart Aquaculture Business Models.** This chapter outlines various aquaculture business models in consideration of their relevance to the attainment of CSA goals. The chapter proposes that no single model can achieve all the goals of CSA. It requires their integration to support poverty reduction through tackling the challenges pertinent to smallholder enterprises.

# Chapter 1
# INTRODUCTION

Successful investment in aquaculture necessitates relevant knowledge and information to guide decisions about why, where and how the sector is performing. This chapter demonstrates the relevance of aquaculture.

## OVERVIEW

Successful investment in aquaculture necessitates relevant knowledge and information to guide decisions about why, where and how the sector is performing. The chapter demonstrates relevance of aquaculture to the global economy although at the local level investment opportunities remain unexploited. Local trends in the aquaculture sector demonstrate its market potential. However, barriers to further growth are prevalent. The chapter outlines potential sites of production and priority areas of investment in the value chain for potential investors in the sector to consider.

## KEY MESSAGES

The global 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 current trends continue, then the global aquaculture industry will transcend commercial fishing by 2026. These figures are promising in terms of the potential contribution of the aquaculture industry to reduce the country's poverty among smallholder farmers.

Policy transformation is required to attract investors to make a difference. Malawi's aquaculture has been growing since early 1990's but remains dominated by smallholder farmers with little market orientation yet, facing numerous production risks leading to low production of stock volumes with unattractive economic returns. Investments in aquaculture are vulnerable to climate change and climate variability and suffer from their impacts.

Climate-smart aquaculture is a "triple win" approach for local aquaculture farmers through: (1) sustainably improving aquaculture productivity and farming efficiency of the production system; (2) increasing adaptive capacity and resilience of aquaculture to climate change; and (3) contributing to climate change mitigation.

Several constraints, such as lack of high-quality fish seed and feeds, low market uptake for tilapia and uncertainty from extreme climate events, should be considered in scaling out the aqua-smart practice. Priority areas for investment are as follows:

Priority Area 1: Production

Priority Area 2: Value Addition

Priority Area 3: Investment Financing

Priority Area 4: Research and Technology development

 

Finfish farmed under aquaculture systems in Malawi

## 1.1 SCOPE AND DEFINITION

### What is aquaculture?

Aquaculture is an industrial process of raising aquatic organisms up to final commercial production within properly partitioned aquatic areas, controlling the environmental factors and administering the life history of the organism positively and it has to be considered as an independent industry from the fisheries.

**Fish farming in Malawi is predominantly based on finfish for both commercial and non-commercial purposes. From an economics perspective, it is important to distinguish between commercial aquaculture and non-commercial aquaculture.**

Commercial aquaculture refers to "fish farming operations whose goal is to maximize profits, where profits are defined as revenues minus costs. The key principles to distinguish between commercial and non-commercial aquaculture are: the presence of a business orientation in the former, in addition to the adoption of remunerated factors of production, such as labour. In Malawi, most smallholder farmers are non-commercial which raises questions about the capacity of the sector to contribute to poverty reduction.

Non-commercial farms rely primarily on household members for labour, while commercial farms tend to hire labour. Commercial aquaculture supplies aquatic products for consumption, including fish, molluscs, crustaceans and aquatic plants, generates profits, creates jobs, pays incomes, wages and salaries, and provides tax revenue.

For commercial aquaculture, the absolute economics of a culture system depends very much on the species, national policy, production technology and market conditions. These preconditions are discussed later in this document. Aquaculture planning must be based on priorities and existence of conditions where aquaculture can make a significant contribution. In Malawi, increased aquaculture production and the attainment of poverty reduction are integral to the national economic development policy.

## 1.2 TRENDS IN GLOBAL MARKET

**Global statistics signal prospects for investment in the aquaculture business. These statistics are important in providing investors with business confidence. Documentation indicates that:**

In 2014, the aquaculture 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.

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. 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 (**Table 1**).

## 1.3 AQUACULTURE IN MALAWI

The fisheries and aquaculture provide essential nutrition, support livelihoods, and

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

| PRODUCTION | 1986-1995 | 1996–2005 | 2006–2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| | Average per year | | | | | |
| **Capture** | *(million tonnes, live weight)* | | | | | |
| 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 |
| 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 |

1 **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.**

contribute to national development in Malawi. The aquaculture sector is important to the country's economic growth and will remain so in many years to come. As the human population grows so too will the demand for animal protein. To meet the demand will require large-scale investments complementary with smallholder businesses.

**A national source of nutrition**

Fish provides over 70 per cent of the dietary animal protein intake among Malawians and 40 per cent of the total protein supply. Fish also provides vital vitamins, minerals and micronutrient.[2] 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).

**Employment for marginalized segments of the society**

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 contribute 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).

**One of the fastest growing economic sectors**

Over the past few years, the sector has displayed signs of growth[3]. 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[4].

The 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 are commercially-oriented, high-value species, which are being caught less by capture fishery (**Table 2**).

**The legal framework supports the culturing of indigenous species**

Four main fish species are commonly cultured in Malawi. There are three tilapias *Oreochromis shiranus*, *Oreochromis karongae*, *Tilapia rendalli* which together account for 93 percent of production. *Oreochromis shiranus* and *Tilapia rendalli* are the most popular species, accounting for over 90 percent of total fish production from aquaculture. One catfish species, the *Clarias gariepinus* accounts for 5 percent of production. Exotic species are subject to controls for the protection of biodiversity as provided by national regulations.

## 1.4 CLIMATE-SMART AQUACULTURE: CONCEPT AND THEMES

Climate Smart Aquaculture is conceptualized from the concept of climate smart agriculture which the Food and Agriculture Organization (FAO, 2010) defined as, an integrated approach to managing landscapes—cropland, livestock, forests and fisheries to address the interlinked challenges of food security and climate change.

***CSA – A common approach to most primary production systems***

In general, strategies for developing climate-smart approaches for aquaculture are broadly like those for agriculture and any other sectors. From a climate smart approach, fisheries and aquaculture are strongly connected although

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

3 This section borrows heavily from CASA Strategy.

4 The National Fisheries and Aquaculture Policy of 2016

**Table 2: Trends In Malawi's Annual Fish Production And Growth For Capture Fisheries And Aquaculture[1]**

| 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 | |

***Source****:* Department of Fisheries

1 Fish production data was obtained from Department of Fisheries

for the purpose of this toolkit they are delinked to give detailed attention to aquaculture subsector. The themes will remain applicable to fisheries especially the principles of sustainability advocated in the toolkit.

***The CSA focuses on investment development and environment***

All climate smart strategies relate to most, if not all, of the major cross-cutting themes of development and environment. As in other sectors, several issues need to be recognized and reconciled for the 'climate-smart' aquaculture to become the default approach for development. Key considerations include the need to:

- Responding to considerable increases in national demand for aquatic food in the face of climate change and other factors, and address specific issues of food access and livelihoods, across the entire supply, value, and benefit chains.
- Absorbing effectively emerging technologies and adapt to market and socially driven changes within and around the sector.

CSA can contribute to achievement of components of sustainable development, including economic, social and environmental goals, by jointly addressing food security and climate challenges facing and arising from the sector development. The basic pillars of CSA concepts and their application are as displayed in Figure 1 and discussed in the subsequent sections.

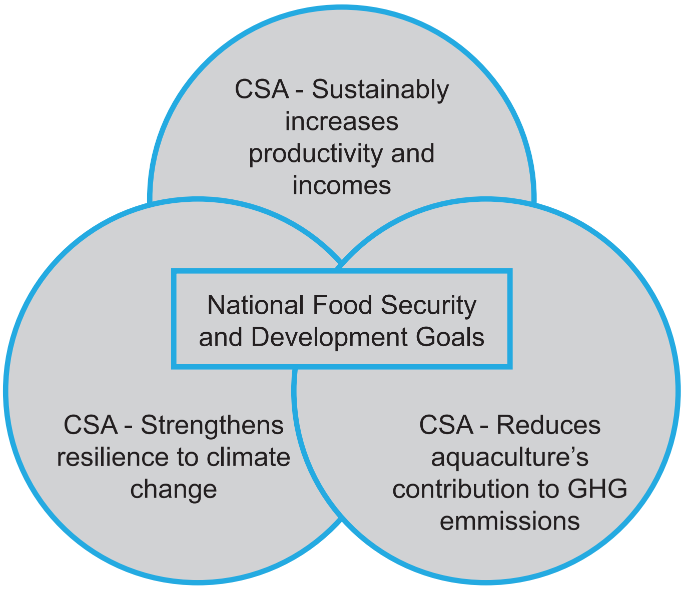


**Figure 1 – The Conceptual Framework for the Development of the Climate Smart Aquaculture toolkit**

***CSA addresses the challenge of building resilience of aquaculture investment.***

As will be discussed in the subsequent chapter, climate variability and associated impacts exacerbate production risks and challenge the coping capacity of farmers at all scales. The CSA approach to agriculture can easily be adapted for aquaculture, by which increased production is managed for sustainability, climate adaptation, and climate mitigation. This provides the approach to building resilient food production systems to more effectively support development and ensure secure sustainable food security in the face of climate change.

***A resilient aquaculture investment results in triple co-benefits***.

The climate-smart approach pursues three primary objectives (Figure 1) towards reconciling trade-offs for building resilient systems on a local and a global scale across time: (i) Sustainable increase in production and incomes (ii) Climate change adaptation (iii) Climate change mitigation.

***CAS is an approach to achieving sustainability.***

The foregoing facts suggest that achieving environmental, economic and social sustainability in aquaculture, investors must, in context, define and embrace the CSA approach, address current barriers to investment and identify impactful investment opportunities taking into account adaptation, food security and mitigation needs at different scale of the value chain.

***CSA calls for aspirations of all players in the sector.***

Key players may include fish farmers, fish-feed producers, processors traders, and transporters. Investors have a vital role to play through their power to reallocate funds away from unsustainable forms of aquaculture. CSA approach is a tool in protecting the environment through adequate market pricing for natural resources through commercialization.

In developing this toolkit, it was 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. 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. The third chapter in this toolkit provides models of financing arrangements that investors would explore to utilize.

## Adaptation and Resilience

One step towards implementing climate-smart aquaculture involves the diversification of the industry through climate resilient species and varieties that are also good candidates for aquaculture. The basic principle of resilient agroecosystems is the conservation and recognition of biodiversity. This principle promulgates that the greater the biodiversity, the more the system is productive and resilient in the face of climate variations, pest infestation, or diseases.

## Diversification Guidelines

It is, however, important to consider the following guidelines:

Diversification demands information. Identify knowledge gaps and seek expert advice.

Diversification should anticipate, adapt to and mitigate the effects of climate change.

Diversification should be compatible with local ecosystems and not reduce aquatic biodiversity.

Diversification should be compatible with other responsible food producing sectors.

Diversification should comply with national and international laws, codes of conduct and conventions.

Diversification should be planned in consultation with all stakeholders and be attractive to farmers.

Diversification should minimize risks from pathogens and predators.

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

***CSA promotes diversification of indigenous species for resilience.***

The use of many different species provides for the ability of the investment to withstand the impacts of climate change – hence achieving resilience of the farming industry. However, this should take into consideration of the dynamic trade-offs, exploration of climate resilient fish for aquaculture which can include the optimization of already cultured species, creating sustainable options for new species, and evaluating the socio-ecological impacts.

## Increasing Productivity and Incomes

***CSA advocates factoring both economic and ecological perspectives into investment.***

**The concept of productivity in economics corresponds to the relation between the volume of production and the means of production used to obtain it.** It measures the efficiency of production processes and their organization. It is a complex concept used to measure and interpret based on the interrelations between means of production and processes, a production factor that can be used for several purposes but largely to determine market competitiveness of the investment. **This in turn helps investors how to reduce production costs to maximize profits and overall incomes.**

Ecological productivity corresponds to production per unit of biomass (the cumulative mass of organisms occupying the same space. Production expresses the formation of tissue per unit of time (cumulative mass of organisms occupying the same space.

The increase in mass of farm-raised fish is related to the production (kg/ha/year). The yield or efficiency of the farm is the ratio of consumption (by a herbivore or carnivore) to production of the resource exploited (plants or prey, respectively). The yield or ecological efficiency is the ratio of production of two successive trophic (ecological) levels (plants and their consumers, the herbivores).

Biodiversity or indeed diversification of cultured species can help to increase productivity according to two mechanisms. The increase in species richness (the number of species) increases the probability of having (1) higher–performing species and (2) species that use complementary resources. The choice of species and the level of diversification can determine productivity of the investment.

## The need for mitigation in the aquaculture subsectors

Global GHG emissions from terrestrial livestock supply chains have been estimated to be 7.1 Gt CO2e (carbon dioxide equivalent) per annum (Gerber et al., 2013)[5], with most emissions arising from enteric fermentation, feed production and manure management. In contrast, the global emissions from aquaculture (the farming of aquatic plants

5 Gerber, P.J., Steinfeld, H., Henderson, B., Mottet, A., Opio, C., Dijkman, J., Falcucci, A. & Tempio, G. 2013. Tackling climate change through livestock – A global assessment of emissions and mitigation opportunities. Rome, FAO. 115 pp.

and animals) have not been quantified, despite this being the most rapidly growing food sector.

Feed for the fish is made from a range of raw materials, which are sourced from the country in which the farm is located, or from international suppliers. In Malawi most of the floating feed comes from Zambia. Emissions of GHG arise during production of these raw materials (e.g., energy used by vessels that capture fish to produce fishmeal, and nitrous oxide (N2O) emissions arising from crop cultivation), and during their subsequent processing and transportation. Aquaculture feed production requires energy, to grind and mix the raw materials, to make the pellets and to dry them. The total energy used depends on local energy supplies, as well as on production efficiencies. After production of the feed, transport is again involved to move the feed to the farms where it will be used. Aquaculture farms are situated in a range of different sites, depending on the requirements of the species and the availability of land and water. Changes in profitability of aquaculture and other land uses have sometimes led to land being converted from agriculture to aquaculture.

Furthermore, land may also be taken for aquaculture, by converting it from grassland, riverbanks or other natural habitats. The farmed species are kept in different enclosures, depending on the species and the environment. The most used fish enclosure is a pond, and tanks and net cages are also widely used. Good water quality inside in the enclosures is essential to the health of the animals farmed, and poor water quality may lead to increased GHG emissions, as excess nutrients are lost from the system and are broken down. Similarly, poor feed quality may reduce fish performance and increase GHG emissions. Some research suggests that well managed aquaculture ponds may act as carbon traps and contribute to mitigation (for example if sediments are later used for agriculture), thus making GHG emission accounting even more complicated (Verdegem and Bosma, 2009)[6].

## 1.5 PRIORITY AREAS OF INVESTMENT IN MALAWI

Aquaculture development in Malawi is constrained by several challenges namely: limited availability of quality fingerlings, poor feed and low participation of large-scale investors. The use of low-quality feed has implications not only on productivity but also on greenhouse gas emissions as will be discussed later. Investment opportunities at a range of scales are available in both the aquaculture and value-added sectors, or in a more integrated approach. These have both national and regional potentials.

### Priority Area 1: Production

Large to very large-scale cage culture of tilapia for national, regional and international markets development and supply of high-quality aquaculture starter and on growing feeds for tilapia and African catfish.

### Priority Area 2: Value Addition

Diversification of existing tilapia fish processing, and development of tilapia products; organisation of capture and value addition for small-scale in Lake Malawi and other lakes.

Small-scale, more specialised opportunities may also exist in producing ornamental freshwater species and in organising supply and external markets for food products. Potential partners can be identified for all of these themes, and indications are that joint ventures or other commercial initiatives could be established in a relatively short time.

### Priority Area 3: Investment Financing

Investment financing in the aquaculture sector is shallow and concentrated in two local private investors (i) Press Corporations invests in MALDECO (ii) Pacific Limited invests in Chambo Fisheries Limited. Beyond these, only small-scale individual

6 Verdegem, M.C.J. & Bosma, R.H., 2009. Water withdrawal for brackish and inland aquaculture, and options to produce more fish in ponds with present water use. Water Policy, 11(S1): 52-68. The large proportion of this section has been lifted from Food and Agriculture Organization Of the United Nations Rome, 2017. Greenhouse gas emissions from aquaculture A life cycle assessment of three Asian systems

Development of specialist hatchery and seed production for tilapia and catfish; provision of service and support functions for commercial and artisanal producers.

A sophisticated hatchery

A large-scale feed mill

Fish processing

investors have established producer SMEs using their own financing. As a result, the integration of the aquaculture players into the formal financial market is very low.

### Priority Area 4: Research and Technology development

A greater focus on climate mitigation and climate adaptation techniques for SHFs is an important area of investment that would go a long way to enhance agribusiness investments in Malawi following cyclical climate impacts such as droughts and cyclones. In some areas, floods have great impacts on fish stocks.

## 1.6 POTENTIAL AQUACULTURE SITES

**Lake Malawi has potential for fisheries expansion. The various targeted species found in Lake Malawi alone have an estimated catch potential in the range of 120-200 000t, as estimated by the ODA/ SADC Pelagic Resources project (M. Banda, pers. comm.).**

Other water bodies are overfished (Lake Malombe), prone to desiccation (Lake Chilwa) or threatened by water hyacinth, Eichhornia crassipes (Lower Shire). Identified virgin stocks in Lake Malawi, however, require expensive deep-water trawls. It is unlikely that

Aquaculture technology on large scale

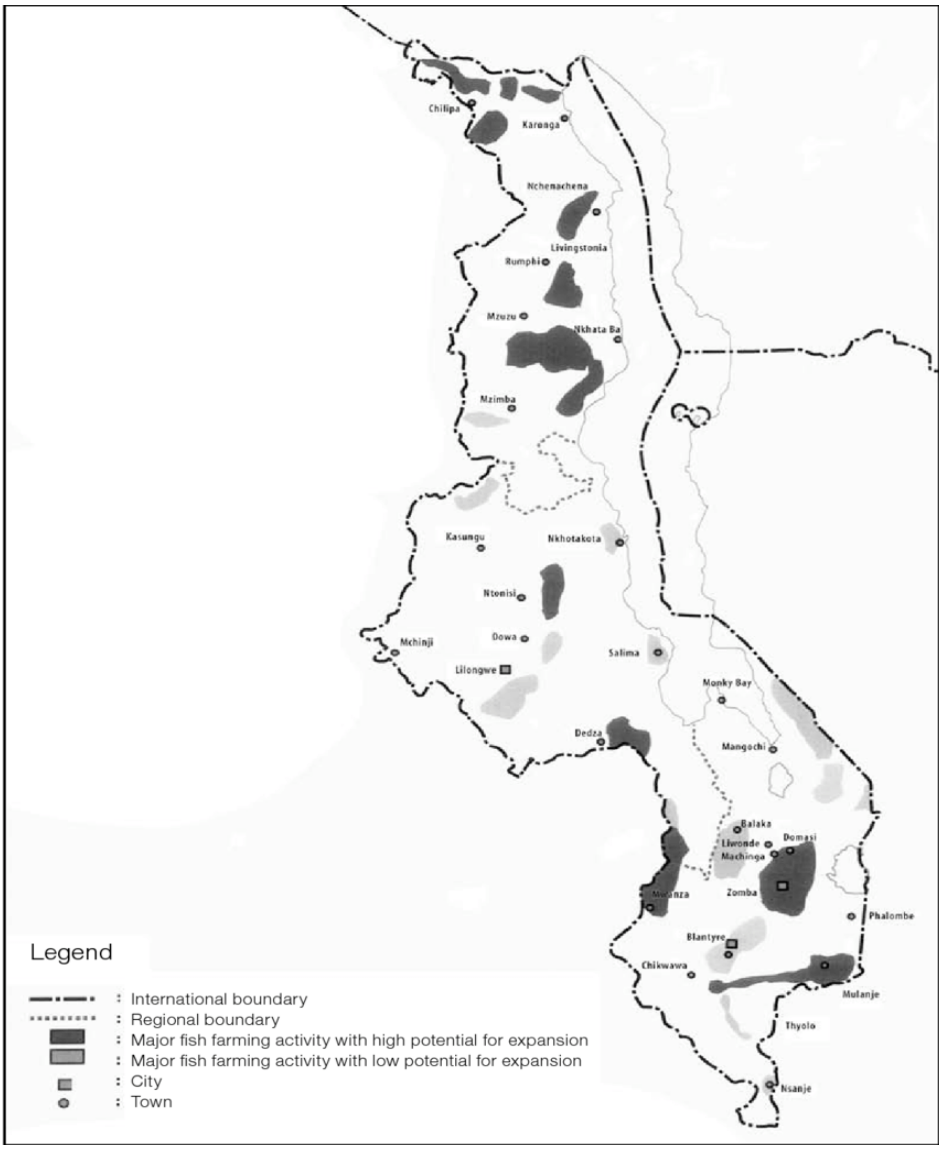


**Figure 2: Potential sites of aquaculture investment in Malawi**

these developments will benefit small-scale operators and economic viability remains to be demonstrated. Malawi is now a net importer of fish to supplement its needs. It all suggests that there remains unexploited potential to increase productivity in the aquaculture subsector to meet the growing demand.

## 1.7 SUMMARY

Aquaculture is one of the fastest growing food industries in the world and the global market has been expanding. The aquaculture subsector in Malawi provides national needs, employment and contributes to national economic growth. However, the sector is dominated by small scale farmers with limited capital input. Thus, the sector is still in its early stages of development yet holds great opportunities for potential large-scale investors to consider. Investment opportunities exist along the whole value chain. As climate change threatens all primary production systems, the aquaculture subsectors must transform to meet national obligations to adaptation, mitigation and increasing resilience of smallholder fish farmers. Government and partners in aquaculture development should adopt Climate Smart Aquaculture as an approach that will support fulfilling the obligation to adapt, mitigate and increase productivity for increased incomes among poor smallholder farmers. Expansion of aquaculture into major lakes of the country will necessitate institutionalization of the Climate Smart aquaculture to protect biodiversity and ensure the sustainability of the aquaculture investments.

Chapter 2

# AQUACULTURE INVESTMENT RISKS

## OVERVIEW

The success of an aquaculture business requires consideration and management of various types of risks that can affect the investment. Aquaculture is often perceived to be a high-risk sector in comparison with other subsectors such as crop farming. When crops fail, losses can be considerable and the actual risk of failure at any given moment is often unknown due to lack of information. In addition, when considering aquaculture, financial institutions in the country do not think of fish farming, which is arguably the sub-sector with the highest history of failure.

## KEY MESSAGES

In Malawi, smallholder farmers face a unique set of production risks which limit aquaculture productivity. These risks include climate change, scarcity of affordable quality and at times predation and pests and diseases.

Droughts and floods are the major extreme climate events that impose limits in aquaculture production especially inland aquaculture operating under ponds. Floods was away fish stocks while droughts reduce water levels in fishponds forcing farmers to harvest early before maturity. Consequently, 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 commercialization.

While climate change affects aquaculture production, aquaculture also contribute to climate change through release of Greenhouse Gases such as methane. Most fish farmers are using sinking feed which besides being inefficient are susceptible to biochemical processes which release GHGs into the atmosphere.

Markets are naturally volatile and there are no existing market aggregation arrangements. This leaves all SHFs to individually (or in their farmer groups) sell fish within their production localities, at a lower price than they would get in urban markets. At the same time, low production volumes do not inspire investors to invest in downstream opportunities such as offtake marketing, distribution and processing for value-addition.

Aquaculture developments trigger a range of policies which guide potential investors to safeguard the environment, economy and the immediate needs of different interest groups such as women, children and other vulnerable groups. These groups must be protected and benefit from the developments.

Inconsistencies emerge in trade policy and regulation that stifle prospects for aquaculture growth. The National Fisheries and Aquaculture Policy (NFAP) identifies aquaculture as the second policy priority area and aspires to expand the sector to make up for dwindling fish catches, tax policy does not support this aspiration. However, the current tax regime reduces local fish producers’ competitiveness due to the high cost of feed, while fish imports are duty-free.

## 2.1 INTRODUCTION

**This chapter discusses major risks associated with aquaculture, prioritized according to farmers' experiences in the country. The chapter provides information necessary for the designing of an aquaculture investment**.

Representation of a comprehensive risk profile of different producers would be possible when accurate data on production, risk factors and the associations between these can be conducted at different points in time. From the investment perspective, aquaculture, like many investments operate in an environment flooded with a strand of risks. However, with good knowledge and understanding, most if not all possible risks can be controlled. The risks can be broadly categorized as production, market and socio-political risks*.*

**Production risks:** The risks under this category mostly affect the ability of an investment to yield a profit because of production associated failures. These include among others, climatic conditions, pests and diseases etc.

**Market risks:** Markets are an important avenue of aquaculture investment. However, markets are volatile creating risks associated with the inability of an investment to generate a profit. Market risks include also environmental and social impacts that may affect the reputation of the investment and consequently the reputation of the institution involved.

**Political and social risks:** This category of risks is associated with changes in the political or legal system, or in the social acceptance of an investee's production activities. Aquaculture investments in Malawi are likely to flourish when they consider how to integrate the socioeconomic needs of those who surround the investment location.

These three categories of risks are discussed in detail to provide contextual risks to consider at both planning and implementation level of the investments. In the discussion, climate change risks are given a deeper focus zeroing into the theme of this toolkit.

## 2.2 PRODUCTION RISKS

The aquaculture production faces a unique set of risks stemming from its capital-intensive requirement, environmental and climatic changes, and the possibility of diseases that affect farmed fish. The mitigation of these risks should be understood if a famer is to boost investment. Policymakers should provide the policy environment that allows farmers deal with these risks. Capacity building is critically important.

### 2.1.1 Climate Change And Aquaculture

#### Observed Impacts

Current observations indicate that the aquaculture sector in Malawi is vulnerable to the impacts of climate change, but smallholder fish farmers have limited capacity to adapt. Field observation shows that fish farmers in the country have been experiencing climate change in many ways depending on geographical location.

In Blantyre, 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 reach the harvesting stage.

Atmospheric warming could change water temperatures, which might impact production. Droughts could decrease the availability of fresh water to fill ponds or tanks. In other areas such as Mzimba, Rumphi and Phalombe, farmers face torrential rains which at times result in heavy flooding of fishponds, and consequently losing fish stocks.

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 for aquaculture production, but the region is vulnerable to extreme climatic events which alternately occur between floods and droughts.

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.

**Projected Impacts**

Projections indicate also 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:

- temperatures will rise, causing higher evaporation and consequent water stress; and
- high levels of rainfall variability will remain. While there exists less confidence in the exact future patterns of extremes, there is a higher likelihood of dry spells and a higher likelihood of intense rainfall events.

### 2.1.2 Impacts of Aquaculture on Climate

**The aquaculture subsector contributes to climate change through the release of greenhouse gases (GHG) into the atmosphere. The types of GHGs produced will vary according to the farming practices.**

The fish feed and fuelwood in fish processing are the most dominant factors in GHG emissions. However, FAO (2019)[7] recognizes that aquaculture production requires only small amounts of fertilizer, often organic, and in some cases low-energy supplementary feeds, and therefore has a relatively small overall carbon footprint. Nonetheless, FAO also cautions that organic feeding materials used in aquaculture can have significant effects on microbial processes, which in turn affect carbon biogeochemical processes that emit methane ($CH_4$). Methane is one of the gases covered in the Intended Nationally Determined Contribution report for Malawi. Investments must ensure that all investments are compliant with these national obligations.

### 2.1.3 Impacts of Aquaculture on Environment

**Aquaculture is one of the major pathways of Invasive Alien Species, both plants and animals, which can result in loss of biodiversity and ecosystem services. Aquaculture has been responsible for introducing exotic and invasive animals, plants, and diseases around the world, often inadvertently through development assistance.**

**Biodiversity loss**

Ecosystems have been disrupted by these invasive species or diseases, leading to reduced productivity of natural systems, loss of local livelihoods, and threats to local or even national economies. Invasive fish species impose ecological impacts at various spatial temporal scales. These species are the second greatest threat to biodiversity globally. 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.

In Malawi, the intentional use of non-native species has resulted in the spread of IAS. Two invasive fish, Oreochromis niloticus and O. leucostictus, believed to have escaped from aquaculture facilities have recently been found in Lake Malawi catchment in Tanzania (Genner et al.,

7 FAO. 2019. FAO's work on climate change – Fisheries & aquaculture. Rome

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 endemics, 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.

**Water Pollution**

Apart from GHG emissions, water pollution is a growing concern associated with aquaculture. As the sector expands, policies and practices to regulate the sector are critically important. Most fishponds are producing wastewater which has serious implications for the environment. Predominantly, smallholder farmers fertilise their fishponds with organic and inorganic fertilisers. The fishponds are usually adjacent to 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 wastewater for irrigating crops has been adopted. MALDECO has been into caged aquaculture in Lake Malawi which will likely raise environmental concerns. Specific concerns include nutrient loading. These concerns can be addressed with proper technical guidance and following policy and regulatory frameworks discussed in the subsequent chapter.

### 2.1.4 Pest and diseases

Disease is arguably one of the biggest risks associated with most forms of aquaculture. Disease occurrences often emerge from limited investment and aquatic animal health management, associated with the traditional, smallholder nature of farming.

© Malawi24. Fish disease

### 2.1.5 Farming system

The farming system has a profound effect on performance and success rates: the ability of farms to provide a suitable environment and remove waste and unwanted organisms. For example, a pond which takes in and discharges water from opposite, disconnected.

### 2.1.6 Land and pond preparation

The preparation of a farm before stocking is arguably as important as the farming practices themselves. Poor pond preparation affects the water in the pond and, in the case of shrimp farming, affects the animals' health and ability to cope with diseases. Pond preparation requires effort to remove waste from the previous crop, and time to ensure that the water to be stocked is free from pathogens and provides the right environment to welcome the fish to be stocked.

### 2.1.7 Seed quality and stocking density

The most common way pathogens are introduced to a farm is through the infected seed. In this case, it is virtually impossible to remove, meaning the risk of an outbreak and crop failure is generally high. Seed that has been generated from poor-quality brood stock or managed poorly will also perform badly and will either grow slowly or be more susceptible to health problems and failure. The number of seeds stocked per unit area, called stocking density, can also affect productivity and disease risk. The higher the stocking density, the higher the yield in successful crops. However, the lower the stocking density, the faster the growth and the lower the risk of disease outbreaks.

### 2.1.8 Feed quality and management

Most aquaculture production systems use external feed, with only very low-density systems not requiring external feed as they generate enough natural feed in the pond. Feed is most often the largest cost item in aquaculture; it, therefore, offers opportunities for cost saving that can be associated with reduced quality and performance.

The feed must contain enough of the right nutrients in the correct proportions (e.g. the ratio between protein and energy/fat), including micro-nutrients such as minerals and vitamins. In addition to the feed formulation, the practices used to feed the animals are equally, if not more, important. Feeding too little will limit growth, while feeding too much will pollute the water.

### 2.1.9 Water quality management

***The production environment can be ecologically productive when farmers are aware of and act upon the risks arising from failure to comply with water requirements.***

Fish are generally efficient at producing animal proteins since fish float in water, requiring less energy to sustain themselves than animals that stand on land. Keeping water quality is therefore extremely important in aquaculture. Fish not only take oxygen from water; they excrete toxic products like ammonia into the water – these would be toxic to the fish stock if at too high a concentration. The water (and its salinity) is also essential to the osmoregulation (salt balance control) of the fish. Changes in the concentration of oxygen, toxic substances, salt and so on can all dramatically affect the health and performance of a fish. Furthermore, fish are cold-blooded and grow faster at higher temperatures (up to a limit – if too high, their health is negatively affected).

Most farming systems need to extract water from the surrounding environment, sometimes to manage water quality within the farm (e.g. to dilute excess nutrients, provide oxygenated water, etc.) and sometimes to compensate for the water lost through evaporation. The quality of the water to be extracted is therefore very important.

***Biosecurity of the production environment is important.***

Maintaining a suitably bio-secure system is essential, as the introduction of pathogens into the system opens the farm to the risk of outbreaks. It is important that farmers adopt hygienic practices that limit pathogen entry, including the disinfection of personnel before entering the farm, and the disinfection of any tools used in other ponds or farms (including water testing equipment). Diseases from neighbouring farms can spread between farms. Although farmers try to mitigate the risk of infection from neighbouring farms by adopting biosecurity strategies, it is almost impossible to eliminate this risk. Sharing information and collaboration is key to profitable investment.

### 2.1.10 Power supply

Large scale investments such as the Chambo Fisheries Limited operate under high power requirements to activate equipment that increases the water oxygen (e.g. paddlewheels). When power failures occur, oxygen levels can reach dangerous levels, and in extreme cases, the crop can be lost completely.

## 2.3 MARKET RISKS

**Malawi capture fisheries are continuously declining, or at best stagnating. The declining trend coupled with the increasing need to supply fish to a growing population creates positive demand for aquaculture products.**

Nevertheless, there are several market risks that can affect the ability of a farm to be profitable. Several of the reputational risks include practices that should be avoided by responsible investors, even if in some cases they may not have profitability consequences.

Fish price volatility is largely caused by supply demand dynamics. The impact of fish diseases on some countries' ability to produce can create heavy shortages and price volatility. Although the occurrence of disease outbreaks in other countries may benefit the profitability of Malawian producers, this also means that in periods when no major disease outbreak occurs prices may be lower. Understanding this price dynamic is essential to calculating break-even points. 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.

## 2.4 REPUTATIONAL RISK

**Legality of production: Producers are expected by buyers and financial institutions to comply with the existing legal framework, including requirements for:**

- Siting of the farm. Siting or setting?
- Farm construction.
- Compliance with environmental requirements (Environmental and Social Impact Assessments).
- Compliance with social standards.
- Reporting to the government.

## 2.5 POLITICAL AND SOCIAL RISKS

**The political and social risks that could affect aquaculture production in the country include:**

**Sudden policy dynamics**

In policy and regulation, there are inherent inconsistencies that stifle prospects for growth. While the National Fisheries and Aquaculture Policy (NFAP) identifies aquaculture as the second policy priority area and aspires to expand the sector to make up for dwindling fish catches, tax policy does not support this aspiration. The current tax regime reduces local fish producers' competitiveness due to the high cost of feed, while fish imports are duty-free

**Bureaucracy:** The level of bureaucracy varies between different provincial governments; it is not always in compliance with the procedures set at national level. Government policy on the introduction of exotic fish species for aquaculture production remains restrictive. Investment is limited to indigenous species such that non-compliance can lead to loss of stocks.

**Limited inter-ministerial collaboration**: Technically, the Ministry of Agriculture and Food Security through the Department of Fisheries is in charge of fisheries and aquaculture. However, there are other ministries that are relevant to the sustainable development of the aquaculture sector.

**Social friction and conflict**

These often occur when the legal arrangements (e.g. ownership or responsibility) are unclear.

## 2.6. SUMMARY

Aquaculture investments operate in a multitude of risks that if not properly managed can limit the productivity and profitability of the investments. Experience on the ground indicates that, climate change is one of the most important production risks for farmers operating with inland systems. Climate change especially droughts and floods frequently occur and influence the level of production which eventually affects incomes among smallholder farmers who have limited adaptive capacity. Pests and diseases are also associated with climate change and can also seriously affect production volumes. Aquaculture generates environmental externalities which can also affect the long-term sustainability of the investment. While climate change directly impacts aquaculture production, aquaculture also impacts climate through the release of GHGs. Besides production risks, aquaculture investments are susceptible to market dynamics which influence prices farmers can either buy or sell their produce. Lastly, political and social risks are also of great concern to any investment. Some political and social upheavals can affect aquaculture investments. The design and planning of aquaculture investments must therefore consider these risks and, wherever possible provide effective management to enhance the production potentials of the sector. The design principles are discussed in the subsequent chapters for application.

Chapter 3
# INSTRUMENTS FOR SUSTAINABILITY

## OVERVIEW

Aquaculture investments must operate within some guiding principles and regulations in order to achieve sustainability. Climate smart aquaculture promotes all the components of sustainability including environmental, social and economic sustainability. This chapter provides the conceptual framework of sustainability and further guides how various legal instruments can support to achieve sustainable development in aquaculture. This chapter largely guides policymakers to make decisions that are in line with policy frameworks that support sustainable development.

## KEY MESSAGES

Investment in aquaculture comes with national policy obligations and guiding principles. Five aspects to sustainability are relevant in guiding successful aquaculture investment. These include technical, economic, social, environmental, and legal.

Aquaculture generates externalities which justifies the need for implementation of regulatory measures to internalize them for efficiency in production and consumption decisions.

Input and emission controls are employed whenever inputs in production cause negative environmental effects beyond acceptable limits. Input controls refer to requirements to use certain inputs, or prohibitions or restrictions on use of others.

Authorities can also implement technology controls such as mandatory standards or methods, public to enforce producers to use technologies and operating procedures that lessen environmental effects of production or mitigate risk of harmful incidents.

Economic incentives can also be utilized to discourage harmful behaviour and encourage environmentally friendly behaviour. Taxes or fees can be formed to make the industry pay the external costs (i.e., externalities) it imposes on society through environmental harmful industry activities. A straightforward approach would be for authorities to charge the producers through taxes or fees according to their quantity of emissions, harmful inputs or production.

## 3.1 SUSTAINABILITY PRINCIPLES

Investment in aquaculture comes with policy compliance obligations and following some guiding principles. Five aspects of sustainability are relevant in guiding successful aquaculture investment. These include technical, economic, social, environmental, and legal. This chapter largely guides policymakers to understand the basis for making decisions that are in line with policy frameworks in support of sustainable development. Climate Smart Aquaculture works in support of the principles of sustainability outlined as follows:

### 3.1.1 Technical sustainability

**As with any other productive activity, in order to be sustainable, aquaculture must be technically sound and feasible (technical sustainability).** It is necessary for fish farmers and investors to identify the appropriate technologies, either imported or locally produced, and to utilize them properly within the production cycle. Knowledge and technical skills to grow a given aquaculture organism is necessary for investors. Besides aquaculture technical knowledge investments are better supported with soft skills in agribusiness.

### 3.1.2 Economic sustainability

**Aquaculture must be economically viable (economic sustainability).** Otherwise, fish farmers may decide to focus their efforts on other opportunities. Economic viability requires aquaculture farms to be profitable and competitive over time. Without economic viability, aquaculture can only continue if subsidized. Promoting an aquaculture business that is unable to finance itself may be counterproductive and block the dynamism of the sector in contributing to poverty reduction.

### 3.1.3 Social sustainability

Investors should strive to make aquaculture socially acceptable (social sustainability). Social acceptability, also known as social licence, refers to the degree to which aquaculture is accepted by local and neighbouring communities, the various interest groups and society at large. Resentment by these groups has implications on the degree of success of the investment. To be socially acceptable, aquaculture operations should benefit a broader proportion of society, including women and young people, rather than a small elite. Groups with special needs must be given consideration.

### 3.1.4 Environmental sustainability

Investments in aquaculture must be respectful of the environment and their activities must remain environmentally friendly (environmental sustainability). Environmental integrity requires that negative impacts be mitigated, thereby enabling farmers to continue production at the same site over time. Inherent to the very definition of sustainable development, aquaculture activities should maximize benefits from the use of resources without compromising those of future generations. How this can be achieved requires operational guidance which this toolkit serves.

### 3.1.5 Legal sustainability

The development and growth of the sector call for adequate, clear and stable laws and regulations. Laws and regulations clearly define the rights and obligations of each actor and reassure entrepreneurs. Stability is necessary to give investors the time to adapt and adopt laws and regulations and supporting guidelines. Frequent changes may not be conducive to investment and create a climate of mistrust among investors.

## 3.2 THE NATIONAL AQUACULTURE POLICY FRAMEWORK

Operationalizing the national policy framework governing the aquaculture subsector entails application of sustainability principles hinging on CSA as discussed in the preceding sections. 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.

***Climate Smart approach will spur outcomes of the national policy on aquaculture***

The National Fisheries and Aquaculture Policy focuses directly towards 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 creation of wealth and employment in such areas.

Based on these goals, aquaculture and its development are strongly linked with other national development policies 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.

Climate Smart Aquaculture as an approach is a means to expedite operationalization of the policy and supporting instruments. By adopting climate smart practices which will be discussed later in the toolkit, farmers will adapt and sustainably increase productivity and incomes. Table 3 displays the various policy and legal instruments that support the Climate Smart Aquaculture approach.

**Table 3. Some Of The Policies Guiding Aquaculture Investments.**

| POLICY | PROVISIONS |
|---|---|
| **National Environmental Policy (2004):** | The National Environmental Policy of 2004 calls for development of mechanisms for cross sector management; facilitating active participation of local communities and other stakeholders in the 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. |
| **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. |
| **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 centre stage of this policy and therefore relates with aquaculture. |
| **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. |

| | |
|---|---|
| **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 socioeconomic development. |
| **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. Aquaculture investments can be of great value to these vulnerable groups. |
| National Invasive Alien Species Strategy and Action Plan (**NISSAP**, 2021-2030**t**): | 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. |

Other Policies to consider aquaculture investments

**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.

**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.

**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, and 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.

**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[8]. 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:

## 3.3 OPERATIONALISING THE SUSTAINABILITY PRINCIPLES

The aquaculture subsector can realize greater outcomes when the national frameworks and the general guiding principles are operationalized to enhance compliance and accountability of investors. Many controls and procedures are proposed in this section to guide both policymakers and investors to consider.

8 World Bank, 2017, *op cit.*

### 3.3.1 INVESTMENT CONTROLS AND PROCEDURES

The presence of externalities generated by aquaculture justifies the need for the implementation of regulatory measures to internalize the externalities for efficiency in production and consumption decisions. Three major categories of policy instruments can be considered to address externalities and make the aquaculture sector more sustainable. There are instruments using direct command and controls, economic incentives or information and voluntary approaches.

**The direct command and controls**: These controls put restrictions on inputs that should be used, on production level, on types of technologies that should be used in production as well as on emission level. In aquaculture, input restrictions may include a ban on the use of untested fish, or toxic antifouling agents and medicines.

**The output restrictions:** In this case, aquaculture will specify the maximum total biomass of farmed fish that could be produced. Permits can be assumed in the form of aquaculture licenses which may be extended to include licenses for R & D and adoption of Climate Smart Aquaculture.

**Operating procedures and technology standards:** Specified production procedures must standard needs such as Best Available Technology. The direct controls can also be applied spatially in which locations or zones are specified for aquaculture.

### 3.3.2 Input and emission controls

**Input and emission controls**: These are existing policy instruments which can be applied whenever inputs in production cause negative environmental effects beyond acceptable limits. Input controls refer to requirements to use certain inputs, or prohibitions or restrictions on use of others. Government can regulate harmful inputs directly through prohibitions and restrictions, or indirectly by requiring producers to use less harmful inputs.

**Emission controls:** Climate Smart Aquaculture strives to achieve mitigation of GHGs. These controls can be utilized to impose restrictions or prohibitions against emitting substances and pollutants into the environment. These controls have been useful in the EU directives and regulations that apply to the European aquaculture industry. But they may be relevant for the control of inputs and emissions in Malawi.

### 3.3.3 Technology controls and operating procedures

Public authorities can enforce technical controls such as mandatory standards or methods, producers for investors to use technologies and operating procedures that lessen environmental effects of production or mitigate risks of harmful incidents etc. An example is the mandatory Norwegian technical standard for the design, functionality and risk assessments of floating aquaculture facilities, adopted to prevent escapes of fish.

The control describes how floating fish farms should be placed out of concern for conditions at the site, and how it should be operated to reduce the risk of escape incidents. Scotland adopted the Technical Standard for finfish Aquaculture in June 2015, which determines technical standards for fish farm equipment, its design, construction and installation adapted for site-specific conditions.

### 3.3.4 Economic incentives

**The Department of Fisheries and Environmental Affairs Department can facilitate imposition of economic incentives to discourage harmful behaviour and encourage environmentally friendly behaviour**.

The Department would impose taxes or fees to make the industry pay the external costs (i.e. externalities) it imposes on society through environmental harmful industry activities.  Two options are applicable:

The first option is for the Department of Fisheries to charge the producers through taxes or fees according to their quantity of emissions, harmful inputs or production.

The second option is for the Department to compensate producers through subsidies according to the quantity they reduced. Ideally, the price tag of each unit of emission, input or production should be equal to the external cost.

### The Norwegian Case

In Norway, farmers with traceable fish or fish unable to reproduce are subsidized through reduced fee rates in the OURO scheme, which is an environmental fund initially established by the Norwegian Seafood Federation in 2011 to fund mapping, monitoring and removal of escapees from Norwegian rivers (Norwegian Seafood Federation, 2014). Public authorities adopted the scheme and made it mandatory through regulations in 2015 (NFD, 2015). Although the scheme is funded by the aquaculture industry through fees, these are not environmental fees as described above. However, farmers with traceable fish only are not required to pay the full fee (75 % discount), while farmers of fish unable to reproduce are exempt from the fee. Thus, these are being subsidized, which could give incentives for producers to farm fish that are traceable or unable to reproduce.

### The Hungarian Case

In Hungary, public authorities have compensated ecosystem services of semi-intensive and extensive fishponds since 1999. After Hungary joined the EU in 2004, they developed an aqua-environmental measures program funded by national and EU resources, which is now supported by the European Maritime and Fisheries Fund (EMFF) Operational Programme. Hungarian extensive pond farmers who are committed to and comply with the aqua-environmental measures for at least five years can receive approximately 221 EUR/Ha/Five years. Required measures are mainly related to stocking density, zero policy on chemical fertilizers, and measures to protect valuable habitats and protecting nesting birds (e.g. maintaining micro-vegetation, as well as restrictions on anti-predator activities, reed harvest and change of water level).

### Applicability of Economic Incentives to Malawi

Fish farmers in Malawi are grappling to access feed of high quality which is also important in reduction of GHGs emissions in aquaculture. Subsidizing the cost of buying floating feed would go a long way in encouraging farmers to reduce GHG emissions but also improving productivity and incomes.

The prevailing taxation policy allows the import of fish duty-free, while fish feed imports are subject to VAT, putting local producers at a competitive disadvantage. Smallholder farmers use sinking feed which is inefficient and releases GHGs. Government can employ subsidies pursuant to the national obligation to reduce emissions but also the national obligation to poverty reduction. This is in tandem with the principles of Climate Smart Aquaculture.

Currently, there are no companies producing floating feed on a commercial scale. The main barrier is the lack of investment capital by smallholder farmers but also the narrow market that discourages potential companies to invest in feed production. Government can use economic incentives to encourage companies to invest in feed production by exempting the companies from VAT.

### 3.3.5 Information and voluntary approach

This is one of the categories of instruments with many tools which can be implemented by aquaculture producers, industry organizations, communities, NGOs and governments among others. Provision of information about aquaculture production through sustainability reporting, information campaigns or ecolabelling (etc.), actors can support informed consumer decision-making.

The information and voluntary approaches require consumers to trust that the information is credible. The third-party certification is thus often required for those wanting to label their products with established ecolabels. Certifications could serve as a supplementary governance body to public authorities. However, strict rules and standards, as well as monitoring must be in place to do so. Information campaigns can be executed across the country.

The Norwegian aquaculture system comprises both command and control measures and incentive-based measures. The command and control measures include the licensing system, the production area model, the regulations imposed on the aquaculture sector. The incentive-based measures including fines and penalties, earmarked export tax and fees, certification and eco-labelling as well as sustainable reporting.

### 3.3.6 Licensing System

All aquaculture producers must obtain a license for production of farmed fish. The process of obtaining a license is twofold. First, the license will be assigned through assessment of proposals or auction. Then, the license holder must apply to the relevant County Council for approval of the utilization of the license at a specific site. The application process is based on requirements set out in provisions laid down in, and in regulations pursuant to, the Aquaculture Act 200517.

**The first condition is being "environmentally responsible".**

Further, necessary licenses pursuant to the Food Law Act 2003, Pollution Control Act 1981, Harbour and Fairways Act 2009, Water Resources Act 2000 and Animal Welfare Act 2009 must be granted from the relevant authority. The application must also comply with municipal coastal plans (approved under the Planning and Building Act 2008) and nature conservation measures (approved under the Nature Diversity Act 2009). The local coastal planning process is part of a larger planning process that entails "analysing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, and social objectives that are usually specified through a political process" (Ehler & Douvere, 2009, Stokke & Indset, 2012).

The County Governor in the relevant county comes with a statement regarding nature conservation, biological diversity (protection of wild salmon rivers etc.) and fishing and recreational interest. The County Council coordinates the application process and makes the final decision. One license holder may apply for more than one site. The licenses stipulate the maximum allowable biomass (MAB) that its holder is allowed to produce18, but each site also has its own, site-specific MAB. One license can be tied to several sites.

The site-specific MAB is primarily determined by the environmental carrying capacity on the site. There are several types of licenses, ranging from commercial licenses for the production of farmed fish to special licenses for development, research and display. Norway has also issued a number of green licenses in an allocation round in 2013, which aimed to reduce the negative environmental effects of escaped salmon and the spread of salmon lice in commercial production19. These were regular commercial licenses for salmon and trout production with specific environmental requirements tied to each license.

### 3.3.7 The Production Area Model

The Norwegian aquaculture industry again has some major environmental problems, including (i) the spread of diseases and parasites, particularly sea lice, to wild fish populations, and (ii) the genetic and ecological interactions between escaped farmed fish and their wild counterparts.

The failure to deal adequately with these issues, especially the sea lice, as well as a need for a permanent and more predictable system for growth in the industry, were the main reasons why the Production Area Model was introduced. The regulatory reform was based on the recommendations by an expert committee on spatial planning in marine areas.

The new system introduced the notion of production areas, which involves restructuring the coast from 7 regions to 13 production areas (Production Area Regulation 2017), in combination with an operational rule, the 'traffic light system' (NFD, 2016). The idea is that the production capacity within one production area is regulated in accordance with the environmental state of the respective area. Every other year, the authorities must assess whether there is a need to adjust the capacity in each production area.

The new system will monitor the combined footprint from all sites in one production area by using proxy indicators. To date, the environmental indicator is salmon lice infestation on wild fish. The environmental effects of the specific production areas will be designated as "acceptable" ('green'), "moderate" ('yellow') or "unacceptable" ('red'), depending on their perceived condition.

**The Production Area Regulation 2017 regulates the three states, which are often referred to as the traffic lights in the model, as follows:**

**Red production area:** The ministry can scale down the production capacity by regulations if the environmental effects are unacceptable. Any reductions in production capacity do not apply to locations qualified for exemptions due to low impact on the environmental indicators.

**Yellow production area:** Likewise, if the environmental effects are moderate the ministry can refrain from changing the production capacity.

**Green production area:** The production capacity can be scaled up by regulations if the environmental effects are acceptable. Licenses that have previously been downscaled must be adjusted back to the same level as before the downscaling, before increasing capacity in the production area. Companies within one production area can therefore be collectively obliged to reduce the maximum allowable biomass (MAB) associated with their licenses, based on the perceived condition of the production area. A location could be approved for exemption from the collective MAB reduction if various strict requirements.

## 3.4 SUMMARY

Climate Smart Aquaculture seeks to sustainably increase productivity and incomes among smallholder farmers and other investors. Sustainability is a broadly conceived development principle which requires supporting procedures and frameworks in order to achieve it. The CSA approach encompasses and supports the commitments contained in the national frameworks and the general guiding principles. The CSA is a means to operationalizing sustainability of aquaculture investments. All the general guiding principles focus on social, economic, and environmental sustainability. CSA works within these frameworks.

# Chapter 4
# AQUACULTURE FINANCING MODELS

## OVERVIEW

Access to formal credit is among the major constraints to the development of fish farming in Malawi. Both state-owned and private banks are unwilling to finance aquaculture projects because they are unfamiliar with the sector. The sector is considered to be highly risky due, among other things, to the concerns about stock mortality. In this case, SHFs are particularly disadvantaged as most bankers find it difficult to deal with small businesses wanting small loans. Furthermore, banks ask for specific guarantees and most SMEs are not able to provide them. Because access to commercial finances is limited, producers usually raise finance through their own savings when they need working capital or want to invest in expansion.

The lack of basic services should be regarded as an opportunity for entrepreneurs and their investors. Impact capital is relatively limited: few actors are available to service smaller enterprises, and most of these actors operate from neighbouring countries. Larger-impact investors such as AgDevCo and CDC Group have made investments but only in larger enterprises. Impact capital represents a small portion of the total capital available in Malawi. Donor organizations are a key source of capital but, according to some development organizations, they often target larger companies with higher turnover, which are perceived as less risky. This chapter presents some of the possible financial models that interested investors, producers, NGOs and government could consider promoting.

## KEY MESSAGES

Aquaculture farmers in Malawi have limited opportunities to access financial services for their capital expenditures and working capital. The following financing arrangements can help support the growth of the industry:

**Risk Sharing along the value chain –** in this arrangement a risk-sharing model could solve resolve fears have by addressing risks and risk mitigation from multiple players, protecting the lender, the company, or the bank.

**Crowdfunding** – this model works through fintech companies collecting small amounts of money from large groups of people via the internet or other platforms. It may include a joint venture in which the company provides technical assistance and acts as a business partner for the farmer under a profit-sharing agreement.

The case studies demonstrate the various options of financial models with varied success applied in South Africa.  Partnerships emerge as the most important elements of financial models. Most especially the South African Case studies demonstrate this.

## 4.1 INTRODUCTION

Aquaculture farmers in Malawi have limited opportunities to access financial services for their capital expenditures and working capital. Currently, banks in the country often have a limited understanding of the aquaculture sector and find it hard to find bankable opportunities. This chapter explores and guides some financial models for the aquaculture sector. The underlying principle for these models to fit into CSA is the fact that they promote economic sustainability among the SMFs while also serving the interest of financial institutions. Several solutions are considered: to share risks along the value chain; to provide credits after breakeven point; to introduce so-called Islamic Finance; and to use crowdfunding[9].

## 4.2 RISK SHARING ALONG THE VALUE CHAIN

One of the main reasons why banks are reluctant to finance aquaculture is their limited understanding of the risks associated with production. A risk-sharing model could solve this 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.

### 4.2.1 A risk-sharing model

This model aims at minimizing risks for both financial institutions and the value chain actors such as cooperatives, packers, feed companies, banks and donors. It can also include public funding, e.g. in blended finance. 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.

Another 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.

Specific value chain actors that can play a role in risk reduction are the cooperatives, which can provide collateral and arrangements to reduce risks and public institutions, who can provide technical support or access to credit.

### 4.2.2. Insurance

The government can initiate the insurance program through a partnership with the Insurance Companies or the association of insurance companies. Under this partnership, a working group can be formed consisting of producers and insurance companies. The program can be 100% subsidized by the government but later it is expected not to need government subsidy. Insurance for smallholder farmers in this model comes with high administrative costs. For the insurance to be reliable, profitable and professional, the farmers who receive insurance need to:

9 This chapter borrows heavily from Investment Guideline for Sustainable Aquaculture in Indonesia (2018). While the guidelines are basically addressing investment issues in Indonesia their general approach to solutions render themselves amenable to different situations including those of Malawi.

- Be trained on better management practices to increase productivity;
- Have guaranteed access to market;
- Be trained in financial capacity through a financial institution that also provides loans.

This fits into a risk-sharing agreement where the value chain players are better connected, and technical capacity is built into the agreement.

### 4.2.3 After break-even point

The break-even point (BEP) of a production cycle is the point at which the total expenses (working capital) and the revenue are equal. To compute a farm's BEP, three variables should be analysed: variable cost, yield and selling price. In aquaculture, more than 50% of the operational costs are feed related, and the farmer's records are the only source of cost information.

The main challenge lies in generating accurate information for the BEP calculation. However, in the era of growing use of digital tools, it is possible to ensure objective assessments of the amount of feed being distributed. In addition to market price information, such digital tools would therefore enable an objective assessment of the BEP. This model would dramatically reduce the risk borne by the financial institution. This model is not suitable for farmers who require pre-break-even financing.

### 4.2.4 Crowdfunding

Crowdfunding works through fintech companies collecting small amounts of money from large groups of people via the internet or other platforms. It may include a joint venture in which the company provides technical assistance and acts as a business partner for the farmer under a profit-sharing agreement. Investors have online access to the aquaculture investee's progress and can monitor their investment. Funds can be collected in the form of working capital investment, loans or equity investment. Most fintech companies offer working capital as it needs relatively low investment. In the case of equity, funds could also be raised from large aquaculture companies (feed or packer) and disbursed directly to the farmer. The companies would then also have a branding advantage as they would be seen as supporting smallholder farmers. From the farmer's perspective, equity from a large company could also help develop loyalty to the company.

## 4.3 CASE STUDIES ON FINANCIAL MODELS

Three financial models have been adopted in South Africa: (i) Business Partners Ltd; (ii) the cooperative model of Sea Freeze; (iii) the community-based model of lobster fishermen. These models provide lessons at different levels of the financial models applicable in aquaculture. However, details analysis of their feasibility in the local context will be the right direction towards possible Institutionalization

### Case Study 1 – Business Partners Ltd

This model has been financing SMEs in South Africa for over four decades. It began as a 50%–50% public–private partnership with the government of South Africa but today the respective shareholding is 20%–80%. At the start investment in fisheries constituted 50% of the total portfolio although trends have declined.

Financial products include loans, equity shares, and royalty fees based on turnover or a combination of all three products. Business Partners finance differs from one operation to another and packages are flexible. The selection criteria are primarily based on the entrepreneur's experience, business risk, quality of collateral, and entrepreneur's own contribution to the business.

Key factors explaining the relative success of the fisheries sector include (i) Business Partners' extensive technical experience in the sector (ii) building and maintaining relationships of trust with the business people involved in the sector and (iii) a high degree of flexibility in the design of financial packages that reflects the needs of the applicants.

### Case Study 2 – The Sea Freeze Cooperative Business

This model was established by 16 top squid operators and functioned as such for about 12 years until it ceased in practice to be a cooperative in 1997. It is reported to have been very successful, with revenues significantly greater than when members worked individually. Further, that members were part of a successful cooperative helped them when seeking to secure finance as individuals.

### Case Study 3 – Community-based fishermen

Artisanal and small-scale fishing communities remain marginalised from the legal framework in the sense that fishing rights are currently assigned on an individual basis rather than at a community level. Efforts to amend this oversight are being undertaken by community organisers and NGOs. The priorities for the development of small-scale fishing communities include: (a) legal recognition of the community organisation; (b) community-based fishing rights; (c) capacity building in the management of collective business; (d) specialised financial fund for small-scale fishing communities.

## 4.4 SUMMARY

One of the critical barriers to the growth of the aquaculture sector is the lack of access to financial services especially credits for capital input for smallholder farmers. This chapter has given various financial models which policymakers and investors may consider adopting. It remains a long process of linking farmers to, and creating confidence among investors. The long-term assignment is to prove to investors how aquaculture can be a viable investment option. The case studies demonstrate that different financial models have the potential to be implemented in the country.

# Chapter 5
# CLIMATE SMART AQUACULTURE SOLUTIONS

## OVERVIEW

Climate Smart Aquaculture is an approach that subsumes many different practices to achieve the goals of environmental, social and economic goals. Some guiding principles in aquaculture are inherently climate smart provided they are applied properly along the entire value chain. This Chapter describes the Ecosystem Approach to Aquaculture (EAA), adaptation measures at the farm scale, and both local and international case studies that demonstrate the practical aspects of Climate Smart Aquaculture solutions. The case studies depict adaptation to the impacts of climate change such as drought and floods.

## KEY MESSAGES

An ecosystem approach to aquaculture (EAA) is a strategy for the integration of the activity within the wider ecosystem such that it promotes sustainable development, equity, and resilience of interlinked social-ecological systems. It comprises three guiding principles which when applied will benefit in (i) adaptation to climate change for resilience. (ii) human well-being and equity for all relevant stakeholders (iii) compatibility in development.

There are many local case studies which demonstrate some practices that adapt to climate change and also mitigate the release of greenhouse gases from the aquaculture. These include integrated aquaculture-livestock-crop farming (ii) the use of floating fish feed which reduces the decomposition of feed thereby reducing biochemical processes that release of GHGs (iii) partnerships that promote the access to appropriate feed and increase profitability of the investment, among others.

## 5.1 INTRODUCTION

**Aquaculture in Malawi has a broad horizon for improvement.** Climate smart aquaculture allows farmers and investors to enhance adaptation and mitigate climate change in order to build resilience. Adaptation to climate change can be implemented at various levels. The social and biophysical dimensions of ecosystems are inextricably related such that the impact of climate change on one dimension is highly likely to generate a change in the other. Although the change can be a natural consequence of complex interactions, it must be monitored and even managed if the rate and direction of change threatens to undermine system resilience. In this chapter, various approaches and tools are discussed together with case studies to demonstrate the concept and application of climate smart aquaculture.

## 5.2 THE ECOSYSTEM APPROACH TO AQUACULTURE

An ecosystem approach to aquaculture (EAA) is a strategy for the integration of the activity within the wider ecosystem such that it promotes sustainable development, equity, and resilience of interlinked social-ecological systems. Being a strategy, the ecosystem approach to aquaculture (EAA) is not what is done but rather how it is done. The EAA responds to three principles:

### Principle 1

Aquaculture should be developed in the context of ecosystem functions and services (including biodiversity) with no degradation of these beyond their resilience capacity. This is important in adaptation to climate change for resilience.

Being a human activity, aquaculture will lead to some loss of biodiversity or affect ecosystem services to some extent. Including humans within ecosystems results in changes from their natural state, therefore, we should consider aquaculture i.e. the production system or culture facility be it a cage or pond or other, as an "aqua (cf. "agro") ecosystem", and its surrounding or external environment embedded in the wider ecosystem e.g. a river, reservoir, coastal bay, open seas. This wider ecosystem may vary from essentially undeveloped to heavily modified. In the former case, ecological issues are likely to be of greater concern (societal perception) than in the latter case where aquaculture is within an already changed agro-ecosystem. Some of these concepts have been applied in Malawi where integration of aquaculture and agriculture has a long tradition, especially at small-scale production.

Nowadays such concepts face greater challenges in other continents where aquaculture is a newer activity and even in the Asian region due to aquaculture intensification (Troell, in press). Indeed, they may be especially difficult to apply in intensive large-scale farming worldwide. Integrated aquaculture and more specifically integrated multitrophic aquaculture (IMTA) has been practised in Asia/China since the beginning of aquaculture, this is due to their ancient concept of treating effluents and residues from farming practices as resources rather than as pollutants. However, in the western world where aquaculture is more recent, there is no tradition of using effluents as useful inputs for other production systems and it becomes more difficult to apply the idea of integrated aquaculture and IMTA not even in the small-scale farming. A key issue here is to define or estimate the resilience capacity or the limits to the acceptable environmental change (Hambrey and Senior, 2007; Hambrey, Edwards and Belton, 2008, this document) . In the case of biodiversity, local declines may be acceptable (e.g. below fish cages) as long as such losses can be compensated and restored, at least at the water body scale, in order to preserve ecosystem functions and services. For example, after a cage farm operation is halted it is expected that the relevant biodiversity recovers if there is enough green infrastructure, that is conservation areas or more pristine areas to provide relevant colonization and restoration.

Many environmental impact assessments (EIA) will touch on these issues and yet the tools to address them are either not well developed or used; a promising one is that offered by risk assessment (RA). Relevant questions remain: How much biodiversity are we willing to lose?, at what scale?, what would be the cost?, and how is this balanced with benefits from aquaculture?. On the other hand, aquaculture effects have to be seen in context by comparing them with those from other food producing sectors such as agriculture and livestock farming. Most terrestrial food producing systems, and especially intensive ones, have been achieved after drastically transforming the landscape, (e.g. clearing native forests, grasslands for agricultural purposes) with permanent impacts on original biodiversity; but we historically grew used to those while aquaculture is a rather new development worldwide. Efforts need to be made in order to permanently monitor aquaculture effects on biodiversity to make sure that such effects do not result in serious/significant losses of ecosystem functions and services. In this respect real values of ecosystem “goods” and services should be integrated into micro and macro environmental accounting. In summary, developing aquaculture in the context of ecosystem functions and services is a challenge that involves defining ecosystem boundaries (at least operationally), estimating some carrying capacity and holding capacity and adapting farming according to it. This requires to consider ecosystem services to be preserved or guaranteed. With more intensive aquaculture practices some modelling and predicting tools are needed and are becoming available. Mitigation practices which consider ecosystem processes such as integrated aquaculture should be considered more seriously, particularly in the intensification process.

### Principle 2

Aquaculture should improve human well-being and equity for all relevant stakeholders. This principle seeks to ensure that aquaculture provides equal opportunities for development and that its benefits are properly shared, and that it does not result in any detriment for any groups of society, especially the poorest. It promotes both food security and safety as key components of well-being. This principle coincides with the need to increase productivity and increase incomes as promoted by CSA approach.

Improving human well-being should go beyond the direct contribution of aquaculture (or the attempts to use it for the purpose) to solve hunger especially in the regions where this activity is newer. In these cases, its main contribution to local livelihoods comes from the increase in employment opportunities and also from the direct small business, local marketing of products.

### Principle 3

This principle makes recognition of the interactions between aquaculture and the larger system, in particular, the influence of the surrounding natural and social environment on aquaculture practices and results. Hence this principle also acknowledges the opportunity of coupling aquaculture activities with other producing sectors in order to promote materials and energy recycling and better use of resources in general. There are examples of integrated production systems e.g. livestock-fish farming and fish-rice production.

### Case Study 1 – Ecosystem Approach to Fisheries and Aquaculture for Food Security in Nicaragua

The tropical mangrove estuary Estero Real is located along the north Pacific coast of Nicaragua. The estuary was declared a protected site in 1983 while in 2003 it was recognized by the Ramsar Convention as an area of international interest. It is at high risk of degradation partly due to shrimp fisheries and aquaculture as well as agricultural practices, urban waste, mining and deforestation in the higher parts of the basin.

Heavy sedimentation from poor watershed management, the increased use of pesticides and the loss of mangrove forests are also threatening coastal aquaculture, fisheries and biodiversity in the mangrove ecosystem. Climate variability and climate change are putting additional pressures on the estuary.

To protect this area national and local fisheries and aquaculture institutions in Nicaragua have led the implementation of the ecosystem approach to fisheries and aquaculture (EAFA) in Estero Real. FAO has supported this initiative through participatory planning and development of management plans. This approach allows fishers and fish farmers to maintain and increase food and income from fish products in the Estero Real, while preserving ecosystem services and increasing community resilience to climate change and other factors.

Thanks to this project, coastal fishery and aquaculture communities have become better informed and more resilient to the impacts of climate change and other threats. Following extensive information gathering and support activities, stakeholders agreed on a management plan currently in place made up of four main components:

- Improvement of environmental management of aquaculture and increased preparedness to climatic related stress by the development and implementation of a monitoring system of the aquatic environment.
- Generation of alternative livelihood opportunities for small scale fishermen, mostly in aquaculture, to avoid negative fishing practices that might threaten biodiversity, ecosystem resilience and their own livelihoods.
- Improvement of national/local governance and strengthening collaboration of different institutions that are involved in the management of the area including private sector.
- Dissemination and communication of the management plan, to foster local involvement, create ownership and improve follow-up. This approach has helped increase understanding of the need to improve linkages with other sectors such as agriculture and future steps will be taken to address this need. The process has facilitated and improved livelihoods for small scale fishermen and women that are now involved in two very successful shrimp farming cooperatives that are working in partnership with the national fisheries institution and larger scale shrimp farming cooperatives. The EAFA management has helped local stakeholders become more aware of the impacts of climate change and other external threats and understand better the need to improve management of natural resources to increase their own resilience.

## 5.3 AQUACULTURE ADAPTATION AT FARM SCALE

Addressing climate change involves actions that either reduce the amount of carbon dioxide and other GHGs in the atmosphere or prepare society for the impacts associated with climate change via adaptation. How effective mitigation and adaptation activities depend on the temporal and spatial scale of impacts and action goals, and the context of the activity. Practicing farmers should be aware of the various practices for both adaptation and mitigation which in the long-term will help their resilience to climate change.

In Malawi, aquaculture is impacted in many ways as discussed earlier in chapter 2. The impacts of climate change on aquaculture include reduced yields, extreme variability in yields, reduced profitability and increased risks. These impacts often occur at the farm scale and therefore need actions at this scale (Table 5).

**Table 5. Potential adaptation measures in fisheries and aquaculture**

| Impact | Adaptation measure |
|---|---|
| **Reduced yields** | Access higher-value markets |
| | Shift aquaculture to non-carnivorous commodities |
| | Selective breeding for increased resilience |
| | Moving/planning siting of cage aquaculture facilities |
| | Change aquaculture feed management: fishmeal and fish oil replacement |
| | Improve water-use efficiency and sharing efficacy (e.g. with rice paddy irrigators) in aquaculture |
| | Aquaculture infrastructure investments (e.g. nylon netting and raised dykes in flood-prone pond systems) |
| **Increased variability** | Precautionary management |
| **yield** | Ecosystem approach to fisheries/aquaculture and adaptive management |
| | Shift to propagated seed for previously wild-caught seed stocks (higher cost) |
| **Reduced profitability** | Diversify livelihoods, markets and/or products |
| | Reduce costs to increase efficiency |
| | Change aquaculture feed management |
| **Increased risk** | Adjustments in insurance markets |
| | Insurance underwriting |
| | Weather warning systems |
| | Improved communication networks |
| | Workshops to teach data gathering and interpretation |
| | Compensation for impacts |
| **Reduced pond water levels** | Early harvesting |
| | Constriction of deep ponds to a depth 0f 2.5m. |

*Sources:* Adapted from Daw *et al*. (2009) and De Silva and Soto (2009).

## 5.4 CLIMATE SMART AQUACULTURE CASE STUDIES

### 5.4.1 PARTNERSHIP – A SOLUTION TO LOW PROFITS IN AQUACULTURE

**The Niger Delta Case study**

For the Niger Delta's less well-off small-scale farmers, a lack of return on investment is particularly serious if there is no break-even or profit margin at the end of their production circle. Many of Nigeria's farmers left the industry as soon as profits were either small or non-existent in relation to their efforts. The lack of profitability has been associated with the use of low-quality fingerlings and fish feed.

**The Nature of the Solution**

The Chevron Initiative embarked on an agenda called Partnership Initiative in the Niger Delta (PIND) to work with small scale farmers in aquaculture and other agricultural sectors, using a new approach. The Market Systems Development (MSD) or Making Markets Work for the Poor (M4P), is designed to change the way aquaculture markets in the Niger Delta work, so that poorer farmers can benefit from the growth and economic development of the sector.

The major objective is to tackle market failures and help poor fish farmers increase their productivity and yield, as well as to reduce poverty and create job opportunities. According to Market System Development specialist Elekwachi James, when they came to the Niger Delta for the aquaculture intervention project, they encountered difficulties in getting the farmers to sign up for training, who were very reluctant to accept them because they there had been similar donors and government advisors in the past who came but never achieved anything tangible. Most of the farmers believed that MSD officials were wasting their time, hence their loss of interest. However, the MSD officials were persistent and convinced a few farmers to undergo training and radically change their business plans. Within a short period of time, other farmers witnessed the fruits of the training and they joined the system. Eventually, the number of trained fish farmers rapidly doubled.

The MSD approach comprised three elements: (i) production (ii) processing, and (iii) marketing. The PIND foundation linked fish farmers to two fish feed companies □ Ranan Feed and Vital Feeds – who donated fish feed for the demonstration, fingerlings company Brafin Hatchery, which agreed to supply fingerlings, and farmers□ group United Ufuoma Fish Farmers Association (UUFFA) which assumed responsibility for the day-to-day management of the demonstration and also donated ponds.

The Usaid Markets 11 project and the PIND foundation provided a consultant, who has to oversee the knowledge transfer relating to the demonstration ponds. Four ponds were stocked for demonstration. Two of these served as control sites, which were not given experimental treatment but continued with their normal practice (including using homemade fish feeds) while the other two were the experimental ponds, set up to trial the new technology, sorting, fertilising the ponds, and using biomass for feeding.

**Results**

The outcome of the initiative was that after six months, the profit margins from the two experimental ponds increased from 5% to 22%. This was the positive result of the drastic drop in the cost of production, as feeding by biomass reduced over-feeding and feed wastage, resulting in cost savings. The yield also increased, because the fish were fed at the right time. The result of saving feed at the beginning part of the experiment enabled the operators to feed the fish until they reached table size without running out of feed, which had invariably happened under the farmers' conventional practice. Many farmers quickly adopted the new practices – and more and more people moved into fish farming.

Dr Okoro who supervised the demonstration of the practice left as his contract came to an end, but the farmers he had trained were knowledgeable, skilful, young and entrepreneurial, and some of them started teaching new entrants and existing farmers. These entrepreneurs are UUFFA farmers, and today, there are nearly 60 consultants from UUFFA who are delivering training, providing advice and information and transferring technology to existing fish farmers and potentially new fish farmers, all of whom are operating profitably. Another introduced component was training in the Nigerian Agricultural Enterprise Curriculum (NAEC), which is the business side of catfish farming management and helps farmers to keep records which tell them whether they are running at a profit. So, the new consultants were combining NAEC training with the technical delivery of the MSD approach.

After the first harvest, the PIND foundation turned its attention to smoking the harvested fish, which prolongs the shelf life of the fish after harvest and consequently provides the farmers with greater bargaining power in selling their product. Another benefit of smoke-processing is that it decreases the cost of production. This is because when the fish reach table size, they continue to consume a lot of feed and if the farmer doesn't have a ready market, he can slaughter the fish and therefore stop feeding it, while smoking the fish and adding value to it. Smoked fish commands a higher price because it gives a unique taste that goes with Nigerian native delicacies.

The PIND Foundation improved the quality of processing by introducing two new types of processing methods, first smoking kilns, and secondly chorkor ovens offering a cheaper technology for fish smoking, albeit not as efficient as smoking kilns. However, both types are better than the traditional fish smoking technology that introduces a lot of smoke to the final product, making it unhealthy for both processors and consumers.

The smoking kilns technology was the brainchild of the Nigerian Institute for Oceanographic and Marine Resources (NIOMR). The PIND Foundation obtained from NIOMR blueprints for smoking kilns and engaged a local fabricator produce kilns which were then promoted. The Chorkor oven was copied from Ghana, where it is quite common, and the PIND Foundation brought it into Nigeria as well, using local masons to build these, where this method is particularly common in the Nigerian riverine communities.

Marketing presented no great problems, as more than 50% of the fish consumed in Nigeria is imported. Demand exceeds supply and so there is a ready market for the product. All that Niger Delta fish farmers needed was to find ways to produce more efficiently so they could compete with imports. They managed this by reducing their costs of feed, which is the major cost component, and so they could keep their selling prices low which would help them compete with the international importers. According to Chief Joshua Ughere, who has been a fish farmer for over 30 years and Chairman of the UUFFA Board of Trustees, commented after the PIND experiment, this initiative has led to significant improvements in productivity, yield and sales of the farmers due to good working practices and access to new markets.

He said that average profit per fish farmer rose dramatically, largely as a result of increased yield resulting from application of better management practices and cost of production reduced because of the production technologies adopted by the farmers. What the fish farmers were previously doing wrong was corrected - a lot of wastage of feeds had occurred without the farmers knowing; and proper sorting drastically reduced levels of mortality through cannibalism. Most farmers changed their attitude toward farming and more people joined the cluster. At the end of the experiment, the demand for Vital and Ranan feed rose by over 30%, as existing farmers maintained their use of these two feeds and other farmers who were trained by the new consultants followed suit.

### 5.4.2 Increasing productivity and profitability

### The AGRiTT Programme Case Study

**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.

**The Nature of the 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.

About 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 phased out.

**Source**: AgriTT Pilot Development Projects

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.

### 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 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.

One of Mwangonde's fish ponds surrounded by bananas

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

Initially started in 2011 as a horticultural farm, Mwangonde transformed his farm into 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 into a success story.

### 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 protect 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.

**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

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

**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 |

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. The critical issue, 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.

## Sustainable Fisheries and Aquaculture in Zambia – a case study[10]

### The Problem

It has been documented that, in Zambia, rates of malnutrition and undernutrition are high, particularly among small farming households. Around 46 % of the population is malnourished and the stunting rate of 40 % of all children under the age of five is one of the highest across Africa. Population growth, combined with stagnating and declining fisheries yields, have resulted in a decrease in fish consumption in Zambia over the last 50 years. At the same time, fish is an excellent source of micronutrients and should be included in a balanced diet. As a matter of priority, the Zambian Government has committed to increasing fish production.

**The project aims to support the Government in implementing the National Aquaculture Strategy with a focus on national food security and poverty reduction.** In order to increase the availability of fish in local markets, the project promotes sustainable fisheries management in dams in the Eastern Province and aquaculture in ponds in Luapula Province (Box).

### Climate Smart Priority Activities

- **Fisheries management for small water bodies:** In the Eastern Province, local communities adjacent to dams and dam committee members benefit from training in sustainable fisheries management, enabling them to manage fish stocks and water resources sustainably.
- Increasing aquaculture production: Fish farmers in the Province of Luapula receive training in fingerling production, feeding methods and business management, with the aim of increasing aquaculture production in an environmentally, socially and economically sound way.
- **Training of trainers:** Multipliers such as extension service providers receive training to ensure long-term availability of advisory services for sustainable aquaculture and fisheries management for small water bodies.
- **Promoting knowledge exchange:** A platform has been established to connect different stakeholders in the aquaculture sector, furthering cooperation and the development of practical approaches for the future development of the sector.

### Rainwater Harvesting – A Climate Smart Aquacultures Practice

There are approximately 140 dams in the Eastern Province of Zambia that store rainwater during the rainy season. Among other purposes, they are used for fisheries, watering of cattle and irrigating of small-scale farms. Dam committees oversee dam maintenance, management and fishing. In specific training units, members of these committees learn how to keep records, manage fish stocks and monitor fishing. The objective of the project is to provide technical and organisational support to strengthen the management capacity of the dam committees. Usually, between 2,000 and 5,000 people live adjacent to a medium-sized dam, benefiting directly from an increased fish supply. For a sustainable and resource friendly use of the dams, existing regulations need to be complied with and new regulations need to be introduced.

A fisheries management plan jointly drafted by all relevant stakeholders, including neighbouring communities, members of the dam committees and traditional authorities, therefore supports the use of the full potential of the dams. This contributes to increased fish production in the Eastern Province of Zambia, where the poverty rate of 79.9% is well above the national average of 54.5% and 43.3% of children under five years display stunted growth. Better and more efficient dam management helps increase productivity considerably, facilitating access to high-quality fish for the food-insecure population in the region.

10 Global Programme Sustainable Fisheries and Aquaculture. Published by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH Registered offices: Bonn and Eschborn, Germany Division G500 - Rural Development and Agriculture Friedrich-Ebert-Allee 32 + 36 53113 Bonn Germany. https://www.giz.de/en/downloads/giz2020-en-sambia-fischerei-sv.pdf

## 5.5. SUMMARY

This chapter has demonstrated in depth the practices of climate smart aquaculture. The approach promotes practices and measures for adaptation to climate change. The chapter has also shown some practices that are relevant to the mitigation of the sector to climate change. For example, the use of an integrated approach promotes adaptation to climate change, but it can also promote mitigation of greenhouse gases. The resilience of the aquaculture systems is necessary to withstand climate risks which inevitably leads to sustainable increase in productivity and incomes. Partnership is an important element of Climate Smart aquaculture. The case study presented in this chapter shows that partnership is an important strategy to solving the low productivity of aquaculture among smallholder farmers.

# Chapter 6
# BUSINESS MODELS FOR CLIMATE SMART AQUACULTURE[1]

## OVERVIEW

Climate Smart Aquaculture is a process of transformation of the aquaculture sector into a profitable business besides striving to meet nutrition and food security. The vast natural resources in Malawi provides the opportunity to develop aquaculture into businesses of different scales but this must be market-led as among the pillars for sectoral transformation.  It has been recognized that Africa registers a significantly high rate of aquaculture enterprise failure which is partly due to the grossly insufficient practical knowledge of the dimensions, opportunities and risks that characterise aquaculture businesses. The need to adopt appropriate business models for Malawi to support Climate Smart Aquaculture development is urgent.  This chapter provides a summary of the constraints and solutions for Malawian aquaculture and investigates a range of business models that can be applied in towards achieving the goals of CSA. Each model is described and characterised in terms of strengths, weaknesses, applicability and suitability in the context of CSA.

## KEY MESSAGES

A wide range of business models exist but no single model can be used to meet the goals of CSA. A combination of models is necessary given the diversity of goals and actors in the aquaculture value chain. The following models are relevant for inclusivity of the disadvantaged in the society.

**Subsistence farming model**:  This model is often small-scale with limited environmental concerns. It offers opportunities for household nutrition and food security contribution. However, the SFM.

**Scale Based Models:** (i)Small Scale and Smallholder, Medium scale and large-Scale aquaculture enterprise. A common feature is their relevance to food security but can be of environmental concern with scale.  Markets are often internationally and regionally recognized with scale and therefore relevant to poverty reduction.

**Public Private Partnership (PPP) Model:** Partnerships help generating solutions to common problems along the value chain. This kind of model has the potential to addresses all the three goals of CSA. Smallholders can achieve increased productivity and incomes; the private entity can benefit from government through creation of enabling environment and government can ensure mitigation potentials in the sector area realized.

**Ownership Based Models*:*** These kinds of models include companies, and cooperatives.

1 This section draws heavily from: AU-IBAR, 2017. Best Practices and Guidelines to Support Commercial Aquaculture Enterprise Development in Africa. Guidelines for Developing Viable Aquaculture Business Models in Africa. AU-IBAR Reports.

## 6.1 Introduction

**For aquaculture to improve its current growth trajectory and contribute towards achieving the Sustainable Development Goals as envisaged by CSA, most especially importantly, addressing the environment-poverty nexus, value chains must become more profitable, at the same time, more inclusive.**

**There is a growing movement to integrate small-scale farmers and actors into aquaculture value chains through inclusive business models (IBMs).** For an aquaculture farming venture to operate as a profitable business depends on the choice of a business model to adopt. This chapter draws from two comprehensive sources: the review of a host of business models or business structures used in aquaculture and other industries across the world and guidelines for business models for aquaculture in Africa. The choice of models is often driven by specific conditions aligned with CSA. The section summarizes the models and proposes those suitable for CSA taking into consideration of scale, ownership and value chain position.

## 6.2 THE SUBSISTENCE FARMING MODEL

**Malawi's aquaculture farmers follow subsistence farming where production focuses on fish farming for the household but with less market orientation.** This kind of model primarily aims to contribute to household food and nutrition security. Overproduction is rarely achieved, but where surpluses are realized, these are usually preserved by salting or dying, sold or battered.

Subsistence farming is unlikely to make substantive increases in household incomes. This model therefore may not support fundamental goals of climate smart aquaculture except for the goal of food security. However, subsistence farming is characterized by production systems based upon on-farm inputs, and low-cost simple technologies. Such farming is normally integrated with other farm activities.

The subsistence farming model is generally environmentally friendly as the scale of production is too small to cause environmental concerns in the areas of production. Table 1 summarizes characteristic features of the SFM based on both field observation and literature.

**Table 6: Characteristic feature of the subsistence farming model**

| Nature and Characteristics | |
|---|---|
| • Very small scale – often farmers have 1-5 fishponds of small sizes.<br>• Often household bound<br>• Use of local species, resources and environmental services<br>• Limited technologies<br>• Poor supply and application of feed and seed.<br>• Some fishponds are owned by families while others are communal. | |
| **Strengths** | **Weaknesses** |
| • Generally, environmentally benign<br>• Niche use of water and other resources.<br>• Supports women who are often marginalised from other livelihood opportunities. | • Inconsistent production volume and/or quality<br>• Significantly affected climate change<br>• Predation of stock<br>• Limited re-investment of income |
| **Opportunities and means of progression** | **Areas of application** |
| • Significant opportunity for extension service, technology and skills transfer.<br>• Opportunity for value chain progression through providing seed and feed<br>• Opportunity for progression by expanded market access | • Rural areas<br>• Household farming |

## 6.3. SCALE BASED MODELS

### 6.3.1. Small Scale and Smallholder Models

**According to the AU-IBAR (2017) Best Practice and Guidelines Commercial Aquaculture Enterprise Development in Africa, an aquaculture facility with a production capacity of less than 10 tons per annum is regarded as being small scale. It is commonly practised across Africa.**

Small-scale and Smallholder Models are the first progression from subsistence farming. They can be highly advanced and commercially driven entities that produce high-value or niche products. Based on observations in the field in Malawi, small scale aquaculture is generally individually, communally or collectively owned and operated with a direct link or close relationship between ownership and operational duties, with owners often constituting part of the labour force. Some of the characteristics of this type of business model are summarized as follows (Table 7):

**Table 7: Characteristic feature of the SMALL-SCALE model**

<table>
<tr><th colspan="2">Nature and Characteristics</th></tr>
<tr><td colspan="2">• Small scale<br>• Often local community bound<br>• Use of local species, resources and environmental services<br>• Limited technologies<br>• Localised markets<br>• Poor supply and application of feed and seed</td></tr>
<tr><th>Strengths</th><th>Weaknesses</th></tr>
<tr><td>• Local food security<br>• Environmentally benign<br>• Niche use of water and other resources</td><td>• Inconsistent production volume and/or quality.<br>• Significantly affected by changes in climate.<br>• Oversubscription of beneficiaries.</td></tr>
<tr><th>Opportunities and means of progression</th><th>Areas of application</th></tr>
<tr><td>• Significant opportunity for extension service, technology and skills transfer.<br>• Opportunity for progression through providing know-how and better-quality inputs<br>• Opportunities for integration with agriculture<br>• Opportunity for progression by expanded market access</td><td>• Use of local species, resources and environmental services Limited technologies Localised markets Poor supply and application of feed and seed</td></tr>
<tr><th>Strengths</th><th>Weaknesses</th></tr>
<tr><td>• Local food security<br>• Environmentally benign<br>• Niche use of water and other resources</td><td>• Inconsistent production volume and/or quality<br>• Significantly affected by changes in climate<br>• Over-subscription of beneficiaries</td></tr>
</table>

### 6.3.2. Medium Scale Aquaculture Enterprise

A facility that produces between 10 and 100 tons per annum has been regarded as being medium scale but not necessarily the next progression from small scale farming, as many variations exist. Generally, small-scale farms will grow to medium scale farms if the resources and opportunities are available, but medium scale enterprises could also operate optimally at this scale in perpetuity. As is the case with small scale farms, some medium scale enterprises are highly advanced and commercially driven entities that produce high-value or niche products. Medium scale aquaculture is less often individually owned and more commonly owned by communities, companies or as a collective. There generally remains a direct link or close relationship between ownership and operational duties, albeit that ownership is usually positioned in management.

**Table 8: Characteristics of the medium scale enterprises**

| Nature and Characteristics | |
|---|---|
| • Improved application of business principles<br>• Use of regional species, resources and environmental services<br>• Moderate access to technologies<br>• Localised and regional markets<br>• Strong base for growth and improvement | |
| **Strengths** | **Weaknesses** |
| • Indirect food security<br>• Local economic contribution<br>• Potential for progression of the value chain. | • Poor access to capital<br>• High cost of inputs such as seed and feed<br>• Poor tracking of key production performance indicators that affect profit |
| **Opportunities and means of progression** | **Areas of application** |
| • Some opportunity for extension services<br>• Many opportunities for cooperation around inputs<br>• and services<br>• Opportunity for progression by better quality of inputs, advances in technology value addition and access to wider markets including regional and international | • Established agricultural areas<br>• New water and land resources<br>• Integration with existing agriculture infrastructure |

### 6.3.3 Large Scale Aquaculture Enterprise

A facility that produces more than 100 tons per annum is said to be a large-scale enterprise. Large-scale enterprises can grow from medium scale farms, but do not necessarily progress in this manner.

They can be established anew if resources, skills and opportunities exist. Typical large-scale aquaculture entities have access to a broad and robust value chain of supplies and services, harness improved technologies, have access to the required human capital and generally supply well-established markets.

Large scale aquaculture is seldom individually owned and more commonly owned by a collective. Ownership is less often involved in operational duties, and usually acts in management positions or as holders of equity (Table 8).

**Table 9: Characteristic feature of the LARGE-SCALE farming model**

| Nature and Characteristics | |
|---|---|
| • Often independent of government support<br>• Usually highly business orientated<br>• Access to international species and other resources<br>• Broad market reach and export | |
| **Strengths** | **Weaknesses** |
| • Agile and well-defined value chains<br>• Significant regional and national economic contributor<br>• Base for spinoff business | • Sometimes lacks equitable benefit sharing for communities<br>• Can be environmentally damaging |
| **Opportunities and means of progression** | **Areas of application** |
| • Much opportunity for satellite development.<br>• Opportunity for value chain optimisation Progression to new technologies and species is possible | • Where well defined agricultural business is possible<br>• Areas with good resource and infrastructure base |

## 6.4 Ownership Based Models

### 6.4.1. Companies

Notwithstanding the fact that an individual can own an aquaculture facility, the formal economy makes provision for the registration of companies. The nature of such companies depends on national legislative frameworks, but companies can be broadly defined as a formal organisation of one or more individuals or entities that conduct a commercial activity for profit.

Many subsistence and small-scale or smallholder aquaculture enterprises in Africa are not structured into formal companies, albeit they may be regulated by custom and agreement. Although supply of aquaculture products from a company into the formal market is the accepted "Western" means of trade, trade in Africa takes place freely between companies and entities that are not structured into legally recognised companies. Export from Africa to other continents usually relies on formalised buy-and-sell procedures where entities that are not structured into companies participate through formalised third-party companies. The larger an aquaculture operation, the more likely that it will be formalised into a company.

**Table 10: characteristic features of the company model**

| Nature and Characteristics | |
|---|---|
| • Often exists in the formal economy<br>• Geared for business and profit<br>• Often opportunity-seeking and entrepreneurial in nature<br>• Often serves well defined markets | |
| **Strengths** | **Weaknesses** |
| • Well-defined value chains<br>• Usually well organised Good regional economic contribution | • Benefits often limited to company shareholders<br>• Poor access to capital |
| **Opportunities and means of progression** | **Areas of application** |
| • Some opportunity for specialist extension Opportunity for value chain optimisation<br>• Good base for value chain progression<br>• Good base for mentorship of small-scale aquaculture | • In the formal economy<br>• Areas with good resource and infrastructure base |

### 6.4.2 Aquaculture Cooperatives

A cooperative is a derivative of a company and consists of an autonomous association of persons that unite voluntarily to meet their common economic, social and cultural needs and aspirations, through a jointly-owned and democratically-controlled enterprise. Typically, each member contributes equity capital, and shares in the control of the cooperative based on the one-member-one-vote principle (and not in proportion to his or her equity contribution as in most companies).

Cooperatives allow for the harnessing of advantages that flow from the collective pooling of resources, skills and other enablers in the aquaculture value chain. In this, the overall advantage is usually greater than the sum of the abilities and advantages associated with the individuals that make up the cooperative. Cooperatives provide an effective tool for progression for subsistence and small-scale aquaculture but are less suited to large scale enterprises in the formal economy.

**Table 11: Characteristic feature of the cooperative model**

| Nature and Characteristics | |
|---|---|
| • Multiple stakeholders<br>• Often integrated with other agricultural activities | |
| **Strengths** | **Weaknesses** |
| • Dynamic environment due to multiple inputs<br>• Usually, strong representation<br>• Access to funding/capital. | • Management can be fragmented, or disjointed<br>• Lack of direction could result from multiple interests |
| **Opportunities and means of progression** | **Areas of application** |
| • Opportunity for extension services<br>• Opportunity for cooperative buying good base for value chain progression and spinoff of specialist aquaculture business | • In areas where multiple stakeholders require direct benefits.<br>• Within existing cooperative structures |

## 6.5 PUBLIBLIC PRIVATE PARTNERSHIPS

Broadly defined, a Public Private Partnership (PPP) is a contractual arrangement between a public or state agency and the private sector, through which the resources, opportunities, skills and assets of each party are shared in the creation and operation of an enterprise that delivers products or services.

In application to aquaculture, a PPP could consist of private individuals or entities gaining access to state-owned water bodies (e.g., Lake Malawi) for fish farming, in which the resources and enterprise are jointly managed (as opposed to being bound solely by a lease or tenure agreement).

The objectives of Public Private Partnership may include the creation of employment, economic activity, skills, food security and more. Such a joint effort by private and public entities allows for a greater commercial orientation in the beneficial use of state assets. There is huge potential for this model to thrive in Malawi where smallholder farmers are facing continuous challenges with access to capital for meaningful investment but having skills in fish farming (Table 12).

**Table 12: Characteristic feature of the public private partnership**

<table>
<tr><th colspan="2">Nature and Characteristics</th></tr>
<tr><td colspan="2">• Cooperation between government and the private sector<br>• Multiple stakeholders</td></tr>
<tr><th>Strengths</th><th>Weaknesses</th></tr>
<tr><td>• Good access to resources<br>• that are in the public<br>• domain<br>• Dynamic environment due to multiple inputs<br>• Usually, strong representation<br>• Access to funding/capital</td><td>• Objectives of government and private sector could be different.<br>• Management can be fragmented or disjointed<br>• Lack of direction could result from multiple interests</td></tr>
<tr><th>Opportunities and means of progression</th><th>Areas of application</th></tr>
<tr><td>• Opportunity for extension services from within the government that is involved<br>• Opportunity for cooperative buying good base for value chain progression outside of partnership</td><td>• In areas where government-owned and managed resources exist</td></tr>
</table>

## 6.6. STATE-OWNED FACILITIES AND STATE-OWNED ENTERPRISE

State facilities are fully owned by the public sector and are usually established to supply core services and products to a sector. In aquaculture, the establishment and operation of hatcheries for seed production is a typical example that has been applied in many African countries. These entities are seldom operated for the purpose of generating profit but may charge for products and services to cover expenses.

**Table 13: Characteristic feature of the state-owned facilities and state-owned enterprise**

| Nature and Characteristics | |
|---|---|
| ○ Fully state or government-owned<br>○ Usually focussed on support and service provision to the sector (e.g. hatcheries, research, training, etc) | |
| **Strengths** | **Weaknesses** |
| ○ Use of state or government resources to support a business orientated sector good access to resources<br>○ that are in the public<br>○ domain<br>○ Can operate in an environment where profit is a secondary concern | ○ Usually with a rigid objective that is not flexible and orientated to sector needs<br>○ Can become competitive to<br>○ the private sector<br>○ Can be bureaucratic and slow to react to advances in technology and opportunities |
| **Opportunities and means of progression** | **Areas of application** |
| ○ Opportunity for dedicated support to a growing sector<br>○ Opportunity to train extension services Opportunity to provide start-up support to small-scale aquaculture | ○ In areas where government can play a role to provide services to aquaculture |

## 6.7. NON-GOVERNMENT ORGANISATIONS

A non-profit organization that operates independently of any government, typically one whose purpose is to address a social or political community-based issue. May be national or international. The defining activity of operational NGO's is the implementation of projects.

**Table 14: Characteristic feature of the non-GOVERNMENT OR non-profit organizations**

| Nature and Characteristics | |
|---|---|
| • Usually have a developmental or social support objective<br>• Usually not involved in primary production | |
| **Strengths** | **Weaknesses** |
| ○ Good access to international funding and support tools.<br>○ Can operate in an environment where profit is a secondary concern.<br>○ Can provide access to regional and international technologies, human resources and markets | • Often with a rigid objective that is not flexible and orientated to sector needs<br>• Can be project focussed without a broad view of sector needs<br>• Can be overburdened by policy |
| **Opportunities and means of progression** | **Areas of application** |
| • Opportunity for dedicated support to a growing sector<br>• Opportunity to train extension services and introduce new skills Opportunity to provide start-up support to small-scale aquaculture | • In areas where national and international non-profit organisations seek a vehicle for development and socioeconomic support |

## 6.8. VALUE CHAIN BASED MODELS

Aquaculture ventures operate within a value chain that upon progression require new suppliers and service providers' involvement and new markets and offset options to expand. The expansion of the value chain may take place through adding aspects such as hatcheries for seed supply, or processing facilities, within the entity that owns or operates the primary production, while in other instances these additions could be made through agreement and contract to other non-owned entities in the value chain. The formation of value chain partnerships may range from information trade agreements to complex supply and off-take contracts. In all instances, such partnerships are established to optimise a business entity.

In primary production such as aquaculture, the establishment of formalised off-take agreements is a good tool to secure markets, which security can be used to leverage capital and buying power for essential services and supplies.

**Table 15: Characteristic feature of the value chain based models**

| Nature and Characteristics | |
|---|---|
| • Usually formed in a mature industry<br>• Usually formed to optimise value chain performance<br>• Usually involve complementary elements that join in the value chain<br>• Usually in the formal economy and profit driven | |
| **Strengths** | **Weaknesses** |
| • Creation of agile value chains in which transactional costs are lowered<br>• Able to react well to a changing business environment | • Can lead to monopolisation of inputs and services |
| **Opportunities and means of progression** | **Areas of application** |
| • Opportunity for cooperation along the value chain<br>• Opportunity to share resources along the value chain | • Usually in a well-established aquaculture (or agriculture) environment |

A progression from value chain partnerships is where business entities own and operate various elements or components of the value chain. Such integrated value chain ownership may develop over time as an enterprise matures and seeks greater control, more efficiency and lower transactional costs in the value chain, or it may be established from the beginning. The extent to which one business entity controls elements of the value chain can vary and does not preclude the supply of goods and services to other value chains outside of its own business. For example, a fish farming entity that adds a hatchery for seed supply (owned under the same business entity) could become a supplier of seed for its own needs and to other farms.

In globally integrated aquaculture value chains, corporate entities are becoming the norm. In its most advanced form one company (or a close association of companies) will own and operate all aspects of the value chain from raw product production for feeds, hatchery and seed supply, equipment manufactures and supply, grow out, processing and value addition distribution and even retail outlets. In these instances, economies of scale, the lowering of transactional costs and branding are primary drivers of profitability.

## 6.9. MULTINATIONAL MODELS

The integrated value chain ownership model indicated in the previous section can result in the establishment of multinational corporate entities or global companies. These companies are seldom involved in single components of the value chain, usually, farm at a large scale and are often involved in linking distant primary production facilities (i.e. aquaculture farms) to markets in other regions or countries.

Their involvement is a symptom of a global economy in which primary products are produced where the natural resources and climate is better suited to farming, while the products are consumed in a value-added state in economically strong markets in major commercial centres or countries.

**Table 16: Characteristic features of a multinational model**

| Nature and Characteristics | |
|---|---|
| • Usually formed in a mature industry<br>• Usually formed to optimise value chain performance<br>• In the formal economy and profit driven<br>• Often the result of conglomeration of smaller businesses | |
| **Strengths** | **Weaknesses** |
| • Creation of long and complex value chains that are dynamic and market focussed<br>• Global market access large businesses that can seek new opportunities, undertake research and development and capitalise new business | • Can lead to monopolisation<br>• Local or rural communities often don't derive equitable benefits<br>• Can have significant environmental impacts |
| **Opportunities and means of progression** | **Areas of application** |
| • Opportunity for rapid development of spinoff and support business or satellite farming<br>• Can be used as a hub to support local development Can be used for technical support, as well as supply of feed and seed to smaller operations<br>• Can serve as a channel to access new and international markets | • Usually in an environment with good access to infrastructure and logistics, or in new environments that can only be accessed by extension of existing value chains. |

## 6.10 SUMMARY

This chapter has demonstrated that Climate Smart Aquaculture is a process of transformation of the aquaculture sector into a profitable business besides striving to meet nutrition and food security. The vast natural resources in Malawi provide the opportunity to develop aquaculture into businesses of different scales but this must be market-led as among the pillars for sectoral transformation. It has been recognized that Africa registers a significantly high rate of aquaculture enterprise failure which is partly due to the grossly insufficient practical knowledge of the dimensions, opportunities and risks that characterise aquaculture businesses. The need to adopt appropriate business models for Malawi to support Climate Smart Aquaculture development is urgent. This chapter provides a summary of the constraints and solutions for Malawian aquaculture and investigates a range of business models that can be applied in toward achieving the goals of CSA. Each model is described and characterised in terms of strengths, weaknesses, applicability and suitability in the context of CSA.

# Chapter 7

# GENDER CONSIDERATION IN CLIMATE SMART AQUACULTURE

## OVERVIEW

By 2018, the number of aquaculture fish farmers in Malawi had grown to about 15,465, according to a census carried out by the Department of Fisheries. Most of these were SHFs organized in farmer clubs, and only two players were operating at a commercial level. In terms of gender, 61.5% of the SHFs were male, and 38.5% female. Thus, gender relations, demographic trend (e.g., more women than men) and cultural identities vary widely in the country. Obviously, the gender disparity in the fisheries and aquaculture sector is alarming. It needs to be considered when considering how to adapt to complex changes as men and women are differently affected. The designing of CSA initiatives must consider how individuals and households support themselves and try to secure and improve their well-being in the face of climate change. Particular attention should be paid to ensuring participatory gender-sensitive decision-making processes on issues related to aquaculture business. The fisheries and aquaculture sector has an important role to play in gender equality, poverty reduction, and food security. Empowering rural communities by facilitating their organization at the landscape level, through community groups or productive institutions (e.g., Natural Resources Management committees and rural producers' associations), can help these communities are better placed to adopt to allow them improve food and nutrition security besides reducing poverty.

## KEY MESSAGES

Men and women in the aquaculture subsector have different access to productive resources, services, information, and employment opportunities, which may hinder women's productivity and reduce their contributions to food security, nutrition, and broader economic and social development goals.

Climate change poses an increasing risk to aquaculture sector, food security, and nutrition. Climate-smart aquaculture is an approach that jointly addresses food security and climate challenges.

A gender-responsive approach to CSA identifies and addresses the different constraints faced by men and women and recognizes their specific capabilities.

Gender-responsive CSA projects reduce gender inequalities and ensure that men, women, boys, and girls can equally benefit from CSA interventions and practices, thus achieving more sustainable and equitable results.

Gender responsiveness in climate smart aquaculture does not naturally occur. Effective integration of gender necessitates knowledge and skills. Thus, capacity building is urgently needed to empower existing SMEs to realize the goals of CSA.

A training module on how to integrate gender issues in climate-smart aquaculture project should be one of the areas for the next level of the project.

## 7.1. INTRODUCTION

**By 2018, the pool of aquaculture fish farmers in Malawi had expanded to well above 15,000, according to a census carried out by the Department of Fisheries. Most of these were SHFs organized in farmer clubs, and only two players operated at a commercial level.** In terms of gender, 61.5% of the SHFs were male while 38.5% were female.

**Given these statistics, Climate Smart Aquaculture interventions that fully incorporate women and marginalized groups into program design and implementation would prove to be more effective than those that do not.** Fundamentally, men women, and children all play a role in maintaining a viable aquaculture enterprise and its contribution to nutrition and food security. Both genders including vulnerable groups in the society must be considered and consulted in the course of planning, policy, and decision-making processes leading to reform.

**One of the causes of gender inequality in the aquaculture sector is the long-held misperception that livelihoods in fishing and aquaculture are male-only occupations, and women are only involved in post-harvest activities.** Recent research, however, estimates that at least 50 million women in developing countries, often with children at their side, work in the fishing and aquaculture industries, performing a wide range of activities from harvest to post-harvest.

**The Malawi Gender Policy of 2008 seeks to mainstream gender in the national development process in order to enhance the participation of women and men, girls, and boys for sustainable and equitable development**. In line with the Gender Policy, the Fisheries and Aquaculture Policy of 2016 envisages ensuring that:

(i) a strategic enabling environment for the small-scale fishing communities in a gender-equitable manner is developed.

(ii) HIV/AIDS and gender issues are mainstreamed in the fisheries sector strategies and programmes.

(iii) child labour issues in the fisheries sector is assessed and mainstreamed.

(iv) decent employment in small-scale fisheries and aquaculture is promoted; and

(v) access by the small-scale fishing communities to services essential to social and economic development is promoted.

## 7.2. WOMEN ENGAGEMENT IN AQUACULTURE

**Gender is significantly an important socio-economic issue in aquaculture in the country with promising dynamics emerging in the sector.** In Malawi, 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 women farmers due to the high costs of pond construction, which put them out of reach of most individual SHFs. While at individual level very few women own fishponds, most farmer groups include women members. Women are more vulnerable to climate change and malnutrition than men. They are more vulnerable in times of disaster and seasonal variation with high levels of mobility constraints due to limited livelihood options. Women virtually hold responsibility for family nutrient intake besides that woman have a role in home garden management.

**While Climate Smart Aquaculture holds promising impact in improving nutrition and food security, in some areas huge investment is required to achieve this**. In Balaka district, for example, most areas are dry. With climate change although CSA is a promising approach woman are more impacted than men, especially since current adaptation requires more capital input. For example, to adapt to below-average rainfall and the consequent dry up of fishponds, farmers need to increase the depth of the ponds. This extra effort cannot be realistically adopted by women who face limited resources. In these areas other forms of land uses such as livestock farming would prove more viable than aquaculture.

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.

**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[11]. 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[12], and that in Southern 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.)[13]

**A SWOT analysis, our field observation coupled with literature review provide insights regarding the strengths and opportunities which can be utilized to address gender issues affecting women along the aquaculture value chain (Table 7.1).**

11 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

12 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.

13 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

**Table 7.1 – A SWOT Analysis of the gender dynamics in the aquaculture sector.**

| Weaknesses | Threats |
|---|---|
| Women remain active at all stages of the value chain, but they are not sufficiently recognized and supported. | Women's participation at the highest level of decision making in the fisheries sector may face resentment. |
| The gender division of labour inhibits women as producers and cultivators of different types of fisheries stocks. | Women may not be able to access new innovations and technologies on an equal basis with their male counterparts |
| Local processing and marketing of fish by women is labour intensive and undervalued | Continued male domination of the sector |
| Women undervalue their own worth and contributions | Insufficient budget allocation for training and capacity building programmes |
| Women lack requisite organisational and management skills | Non recognition of women as valid research subjects |
| Unpaid and poorly remunerated roles along the value chain | Difficulty for women fisheries associations and bodies to access mainstream leadership |
| Limited control overfishing expeditions and their outcomes | Increased feminization of poverty and low visibility of women |
| Inequalities are embedded in all the social and economic interrelationships among women and men at all stages of the value chain | Disempowerment and possibility for gender-based violence |

| Strengths | Opportunities |
|---|---|
| Women are actively involved at all stages of the aquaculture value chain. | There is an opportunity to enhance women's participation at the highest level of decision making in the fisheries sector |
| Women can be active cultivators of different types of fisheries stock | Improved innovations and technologies for enhanced production of fisheries stock are available and can be accessed to benefit women and men equally |
| Women predominate the local processing and marketing of fish. | Best practices for processing and marketing of fish can benefit women through training and capacity building programmes. |
| Women have extensive knowledge and experience along the value chain. | Research institutions can document women's experiences and knowledge acquired over the years in the capture fisheries subsector. |
| Women organise themselves in groups and associations to maximize their involvement in the sector. | Fisheries associations and bodies are credible entry points for inclusive decision making, learning, networking and accessing of vital resources |
| Women play a multiplicity of roles along the value chain | Greater visibility and leadership roles for women can be promoted |
| Women are major financiers of fishing expeditions | Ability to influence critical decision making based on their economic power |
| There are continuous social and economic interrelationships among women and men at all stages of the value chain | Possibility for enhanced social and gender equality. |

Malawi has the potential for increased aquaculture productivity which if commercialized in approach and linked to sectors such as tourism together with an enabling policy can stimulate increased fish production for both local and regional markets. The lack of a central fisheries management point and limited private sector investment and participation has restarted growth of the sector. The role women play in the aquaculture sector will need extra support to benefit their households.

In practical terms, women would participate effectively and benefit from opportunities and initiatives within the fisheries value chain on an equal basis. Additionally, they would be able to contribute their perspectives on issues and challenges that may arise from the multiplicity of CSA initiatives.

## 7.3 STRATEGIES TO EMPOWER WOMEN

It has been clear that the main motivating factor for their participation in aquaculture is to provide food for their families, in particular, to feed their children and the vulnerable in society. Such a motivation should be capitalized to encourage women to participate in aquaculture training, integrating techniques of soil conservation and water resource management for achieving CSA goals. Major constraints to carrying out this strategy are:

- Lack of extension staff to train the women in aquaculture and the lack of information on appropriate resource use is one of the major challenges which women are facing. A suggested strategy is to use the 'train the trainers' in Climate Smart Aquaculture whereby the literate women who live in the local production area will be trained in order to assist other women on a regular basis. Such a measure would be cost-effective since the women will be in the local area and it would in part eliminate the need for extensive development infrastructure. Further, women with the knowledge of aquaculture can assume a place of importance in the local community. These women can assist in sustaining the aquaculture efforts of other women fanners.
- Women's access to tools can be increased by providing tools on a credit basis for women. Alternatively, women's groups can be provided a set of tools to be used under the management of the group leader. Women have the knowledge and the key responsibility for feeding the fish by utilizing household wastes. The aquaculture scientists can work with them to identify the nutritional quality of various local greens and food wastes as fish feeds.
- If CSA is to empower women and lead to better household food security and nutrition, deliberate efforts are needed to overcome their own conditioning by society on what they should and should not do, e.g., they should not go into the pond, or they should only work close to the home.
- Incorporating gender issues in CSA requires that investors have technical instruments for gender mainstreaming, e.g., gender-responsive planning methods, toolkits, indicators and checklists, technical and gender training, and communications that are relevant to aquaculture.

## 7.4. SUMMARY

Women and men are differently impacted by climate change although women may not be able to access new innovations and technologies on an equal basis with their male counterparts. Women undervalue their own worth and contributions. The opportunity available suggests that women are actively involved at all stages of the aquaculture value chain. The role women play in the aquaculture sector will need extra support to benefit their households. By empowering women to participate on an equal basis in initiatives of in the aquaculture sector, development practitioners would be able to consciously enable women to realise their rights as equal citizens in their communities and the nation at large. Climate Smart Aquaculture cannot achieve its envisaged goals if women are not fully empowered. Women's access to aquaculture tools can be increased by providing tools on a credit basis. Alternatively, women's groups can be provided with a set of tools to be used under the management of the group leader. Women have the knowledge and the key responsibility for feeding the fish by utilizing household wastes. The aquaculture scientists can work with them to identify the nutritional quality of various local greens and food wastes as fish feeds.

European Union

Austrian Development Agency

Norwegian Ministry of Foreign Affairs

Swedish International Development Cooperation Agency