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The appropriateness and sufficiency of public support to small-scale aquaculture producers in Gauteng Province, South Africa

by

Masuping Berta Mofokeng

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DECLARATION

I, Masuping Berta Mofokeng, declare that this dissertation, which I hereby submit for the Master's degree in Agricultural Rural Development at the University of Pretoria, is my own work and has not been submitted by me or anyone for a degree at this or any other tertiary institution.

SIGNATURE: MB MOFOKENG

DATE:

DEDICATION

This dissertation is dedicated to my family. To my son Rethabile Olerato Mofokeng and my daughter Naomi Lehakoe Mofokeng, you inspired and gave me all the strength to complete this dissertation. To my mother, Ntsoaki Francinah Mofokeng, words cannot explain how grateful and thankful I am for your love, unwavering assistance and unfailing support you gave me throughout this difficult journey. To my father, Jobile Petrose Mofokeng, who from a tender age has encouraged education and inspired greatness in me. To my siblings, Ntjheke Mofokeng and Matlakala Mofokeng, you are deeply appreciated.

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ABSTRACT

Aquaculture has become a significant global food-producing sector, where, with the traditional capturing fisheries being depleted, it offers a good opportunity to supplement supply in order to meet the increasing demand for aquatic food as populations grow. In the context of South Africa, the country has a wealth of marine and freshwater resources, and, because of this and diminishing captured fisheries, has a high growth potential. Consequently, aquaculture has been prioritised as an industry that could provide significant potential for increasing employment opportunities, rural and economic development, as well as food supply, while generating earnings and reducing poverty.

Regardless of its potential and prioritisation on the part of government, the sector remains small and insignificant, contributing little to regional, national and global total fish production. The small-scale aquaculture farmers face various challenges that hamper their development and that of the sector. In efforts to address these challenges, the public sector has over the years implemented a number of policies and support programmes such as the National Aquaculture Strategic Framework (NASF), Operation Phakisa Aquaculture initiatives and the National Aquaculture Policy Framework (NAPF) amongst others. Despite this government support, small-scale farmers continue to face challenges, and the sector is growing at a slow rate.

Various studies have been conducted that focus on identifying challenges and recommending possible solutions for aquaculture development in the country. However, extant studies do not assess whether the implemented government interventions or support programmes are appropriate and sufficient for addressing these challenges and developing small-scale aquaculture farmers. The overall objective of this study was to assess the appropriateness and sufficiency of public support for small-scale aquaculture producers in Gauteng Province, South Africa. The study focused on the appropriateness and sufficiency of two aquaculture support programmes, namely, the Aquaculture Development and

Enhancement Programme (ADEP) and the Aquaculture Technology Demonstration Centre (ATDC). These programmes were identified for the purpose of this study, because they are aimed to address major challenges among small-scale aquaculture producers, namely, a lack of access to funding, and skills development.

The study utilised both primary and secondary data. The research approach consisted of a combination of literature reviews, surveys, and stakeholder interviews. Responses from 18 aquaculture farmers and three government departments (the Department of Trade, Industry and Competition (DTIC), the Department of Forestry, Fisheries and the Environment (DFFE) and Free State provincial Department of Agriculture and Rural Development (FSDARD)) that implement the support programmes were captured in Microsoft Excel for data cleaning. Data was imported into the Statistical Package for the Social Sciences (SPSS) for automatic coding, and for further statistical analysis. Statistical analysis methods, such as frequency distribution and comparison analysis, were employed.

The key finding of the study was that small-scale aquaculture producers continue to face challenges, such as lack of access to finance and skills development, regulatory barriers, and increasing costs of inputs and capital expenditure. The findings further revealed that public support available through ADEP that serves to assist small-scale aquaculture with access to finance was neither appropriate nor sufficient. The ADEP was not considered appropriate because the minimum requirements for grant funding are difficult to achieve by small-scale aquaculture producers. Financial support through ADEP is not sufficient due to its cost-sharing reimbursement structure creating a barrier for farmers lacking upfront capital. Furthermore, it does not offer start-up and working capital, which are the major needs for small-scale aquaculture development.

Similarly, the support related to skills development provided through ATDC was fairly appropriate and sufficient, because it offers free fish farming courses and lacks stringent selection criteria, focusing on subsistence and small-scale farmers. However, findings from the 18 farmers interviewed and the two implementing departments, DFFE and FSDARD further revealed that ATDC was not appropriate and sufficient, because it only offers basic fish farming courses, and does not offer comprehensive courses required to start and operate a farm, such as management, financial and personal skills. In addition, due to its location, the ATDC struggles to reach geographically dispersed farmers and poses a challenge owing to limited budgets to cover the cost of transport to the centre, food, and accommodation, which makes the training prohibitively expensive for many small-scale farmers. The findings also showed that similar aquaculture support programmes in China were more comprehensive, in comparison with support programmes in South Africa. ADEP and ATDC did not have the crucial elements required to provide comprehensive support to address financial and skills challenges faced by small-scale producers in South Africa.

In conclusion, the study results demonstrate that small-scale aquaculture is still underdeveloped and continues to face various challenges that limit its potential and development. The government

interventions to address these challenges have had little impact on the development of small-scale aquaculture, and are therefore highly not appropriate and are highly insufficient. Both the programmes that were investigated in this study, the ADEP and the ATDC, are important for the sector, but have proven to be insufficient and inappropriate for providing financial support and skills development required for small-scale aquaculture development. The case of China demonstrates that the aquaculture sector development in China was largely attributable to government policies and support. However, in the case of Egypt, fewer records of such support were found, which may indicate that the development of aquaculture not only depends on governmental support, but also on other external factors that do contribute.

The study shows that there are possibilities and potential for improving the existing support programmes to become more appropriate and sufficient for small-scale aquaculture needs, as well as for achieving government goals. The study provides the following recommendations: (i) aquaculture blended financial model, suggest the ADEP be reviewed and blended with seed funding (start-up capital), which can be offered as a pure grant together with a subsidised loan that offers a low-interest loan for own contribution, working capital and for improving the competitiveness of the farm; (ii) comprehensive aquaculture extension system, which suggest that each province should have an aquaculture demonstration centre based on the demand, where the centres should add business, personal and management-related courses, essential for effective management of a farm, especially financial management, record keeping and other personal skills. Government should also invest in increasing the number of quality aquaculture extension officers and their expertise or skills in aquaculture, and the existing centre, the ATDC, ought to increase its promotion and awareness activities, and proper guidelines as to what they offer should be developed; (iii) aquaculture small-scale development policy, a policy dedicated to small-scale should be developed to address, over and above access to finance and skills development, other issues such as cheap fish imports, regulatory barriers, technology use, alternative energy sources, and research and development; (iv) comprehensive aquaculture research and development will encourage institutions such as Department of Science and Technology (DST), Agricultural Research Council (ARC), universities and South African Bureau of Standards (SABS) to work more closely together with the government to ensure that small-scale aquaculture is protected against proven, failed production systems and species. Further research and development ought to be undertaken in improving and introducing technology, species and feed that are of high quality, suitable for South African conditions, and would improve productivity and income.

Keywords: Aquaculture, small-scale farmers, funding support, skills development, public support.

ACRONYMS

ADEP	:	Aquaculture Development and Enhancement Programme
AAHSF	:	Aquatic Animal Health Strategic Framework
AIPR	:	Annual Incentive Performance Report
ARC	:	Agricultural Research Council
ATDC	:	Aquaculture Technology Demonstration Centre
B-BBEE	:	Broad-Based Black Economic Empowerment
CASP	:	Comprehensive Agricultural Support Programme
CSIR	:	Council for Scientific and Industrial Research
DAFF	:	Department of Agriculture, Forestry and Fisheries
DFFE	:	Department of Forestry, Fisheries and Environment
DRDLR	:	Department of Rural Development and Land Reform
DST	:	Department of Science and Technology
DT	:	Department of Tourism
EC	:	Eastern Cape Province
FAO	:	Food and Agriculture Organization
FM&CP	:	Finfish Monitoring and Control Programme
FOCAC	:	Forum of China-Africa Cooperation
FSDARD	:	Free State provincial Department of Agriculture and Rural Development
GP	:	Gauteng Province
IGDP	:	Integrated Growth and Development Plan
KZN	:	KwaZulu-Natal Province
LP	:	Limpopo Province
MLRF	:	Marine Living Resource Fund
NASF	:	National Aquaculture Strategic Framework
NAPF	:	National Aquaculture Policy Framework
NACA-ASEAN	:	Network of Aquaculture Centres in Asia-Pacific – Association of Southeast Asian Nations

NGP	:	New Growth Path
NDG	:	National Development Goals
NGO	:	Non-Governmental Organisation
NW	:	North West Province
OECD	:	Organisation for Economic Co-operation and Development
OPA	:	Operation Phakisa Aquaculture
PUA	:	Public Understanding of Aquaculture Programme
RADP	:	Recapitalisation and Development Programme
RDP	:	Rural Development Programme
RSA	:	Republic of South Africa
SABS	:	South African Bureau of Standards
SPSS	:	Statistical Package for the Social Sciences
SSA	:	Small-scale aquaculture

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CHAPTER 1: INTRODUCTION

1.1 Background

There are two fisheries components in South Africa, namely wild capture fisheries, and the aquaculture sector, respectively (DAFF, 2014a). The Food and Agriculture Organization (FAO) describes aquaculture as "the farming of aquatic organisms, including fish, molluscs, crustaceans, and aquatic plants" (FAO, 1992, p. 1). In South Africa, aquaculture is defined as “the farming of aquatic organisms, including crocodiles, in controlled or selected aquatic environments (marine, brackish or freshwater)” (DAFF, 2018a, p.6). Harvesting of living organisms that naturally occur in marine and freshwater water bodies or environment are referred to as ‘capture fisheries’ (Green Facts, 2018). The definition of ‘aquaculture’ excludes capture fisheries, where fish is harvested from water bodies (Rouhani and Britz, 2004).

According to the *South Africa Aquaculture Yearbook 2016*, the aquaculture sector in South Africa is divided into two sectors, namely marine aquaculture and freshwater aquaculture (DAFF, 2016). According to DAFF (2017a), the marine aquaculture sector is fast developing in the country and is being conducted along the coastal regions of the Northern Cape, the Western Cape and the Eastern Cape. Freshwater aquaculture is underdeveloped and is dispersed around the country, occurring in all nine provinces. There are three distinctive types of aquaculture producers. The first is represented by commercial aquaculture, comprising producers who undertake aquaculture operations with the main intention of generating profit and who operate on a greater scale as compared with small-scale aquaculture (DAFF, 2018a). Secondly, small-scale aquaculture is represented by producers who employ fewer than ten persons and produce less than 20 tons of fish per annum, with the main intention of making a profit (DAFF, 2018a). Small-scale aquaculture has the potential to contribute to increased aquaculture production, economic development and food security. Thirdly, subsistence aquaculture is represented by producers who produce fish with the main intention of feeding the farmer and family and who sell their surplus fish not for profit but to make contributions to their livelihoods (DAFF, 2018a).

Commercial producers are more developed than are small-scale producers, and operate farming of high value species, such as abalone, oysters, mussels and dusky kob, on a large scale (DFFE, 2019a). The small-scale producers, on the other hand, are underdeveloped and mostly cultivate freshwater species, such as tilapia, catfish, common carp and marron, on a small-scale production. In 2018, the aquaculture production amounted to 6365.8 tons, with marine aquaculture contributing 4244.4 tons, and freshwater aquaculture contributing only 2121.4 tons to the total aquaculture production (DFFE, 2019a).

The underdevelopment and low contribution of small-scale aquaculture may be attributable to the fact that these producers have distinctive characteristics and also face different challenges. There are challenges that usually affect small-scale aquaculture farmers, globally, such as poor extension services, poverty, poor quality fish seed or fingerlings, absence of information, and inadequate fish feed (Mwanja and Nyandat, 2013). Madibana *et al.* (2020) have mentioned that the main challenges confronting emerging aquaculture farmers and emerging entrepreneurs in South Africa are high costs, difficulty in obtaining funding, land, water, business plans and technology, and inadequate supporting policies and regulations. These challenges hinder the growth of small-scale aquaculture and the farmers' ability to play an important role in the development of the sector.

The South African government has implemented numerous policies and programmes that serve to support and assist small-scale aquaculture to develop in the country, with the aim of accelerating growth, increasing aquaculture production and food security, and reducing poverty (DFFE, 2019a). These policies and programmes include: (i) the National Aquaculture Strategic Framework (NASF), which provides guidelines to assist government in facilitating the expansion of aquaculture (DAFF, 2012); (ii) the National Aquaculture Policy Framework (NAPF), which provides the medium-term and long-term plans for aquaculture development (DAFF, 2013a); (iii) the Aquaculture Development and Enhancement Programme (ADEP), which was developed to provide financial support to the aquaculture sector (DTIC, 2013); (iv) the Operation Phakisa Aquaculture initiative, which was introduced as a way in which the government intends to execute policies and programmes better, quicker and more efficiently (DFFE, 2016); (v) the Aquaculture Technology and Demonstration Centre (ATDC), which provides skills development, training, and research and development; and lastly, (vi) the Aquaculture Bill, which encourages responsible aquaculture development in South Africa (DFFE, 2019a).

1.2 Research problem

As stated in the previous section, small-scale aquaculture producers are constrained by numerous challenges, hampering their growth, empowerment and participation in the aquaculture value chain. Government interventions provided through various support programmes have been implemented as a means of developing the sector and addressing the challenges that hinder the sector's development, with a main focus on small-scale farmers.

In reality, despite these efforts through government support, the sector is still small, with production volumes being low and insignificant, even when compared to that of similar countries, such as Egypt or Nigeria (Operation Phakisa, 2014). The small-scale aquaculture farmers still face numerous challenges that hinder their growth and development (Madibana *et al*., 2020). Therefore, they are unable to meet government targets as potential providers of increased production, job opportunities, food security, income generation, and economic as well as rural development.

According to Njokweni (2015), aquaculture requires highly skilled labour because it is highly technical and capital-intensive. Furthermore, high capital investments in terms of machinery and species development are required for effective aquaculture. Rouhani and Britz (2004) conducted a baseline study on how aquaculture in South Africa contribute to rural livelihoods. The study found that, regardless of attempts to promote rural aquaculture, aquaculture projects that are not provided with continuous technical support have failed, and are not necessarily restrained by access to water, infrastructure and land. Njokweni (2015) argued that appropriate institutional arrangements are required to be in place in order for the public sector to attain its goals in terms of aquaculture. Phosa (2018) agreed that support, such as access to funding and feed production locally, would assist small-scale aquaculture to contribute to income generation in rural communities.

Studies by Madibana *et al*. (2020) Njokweni, (2015) and Phosa (2018) have revealed that small-scale aquaculture producers continue to encounter numerous challenges and remain underdeveloped. The underdevelopment of small-scale aquaculture continues, despite various government interventions being implemented, over time (DFFE, 2019a). This acknowledges the point that the achievement of government programmes has remained limited thus far, with low aquaculture production and low impact on the economy (Operation Phakisa, 2014). Britz *et al*. (2009) emphasise the point that the backbone of the country's aquaculture development would be to establish and develop small-scale enterprises. Therefore, increased overall aquaculture production, food supply, job creation, and geographical spread of aquaculture in South Africa would be the result of the development of small-scale aquaculture.

Several studies have been conducted, focusing on the challenges facing emerging aquaculture, small-scale aquaculture, the overall sector in South Africa, and possible solutions (e.g. Madibana *et al.,* 2020). Various government publications, such as the NASF (DAFF, 2012) and Operation Phakisa Aquaculture Lab Report (Operation Phakisa, 2014), have identified challenges faced by the sector and have provided action plans to be implemented to grow both the overall sector and the small-scale aquaculture sub-sector. These publications agreed and concluded that, for small-scale aquaculture farmers to succeed and their goals to be realised, government and private sector support is required. A survey undertaken by Britz *et al.* (2009) determined that the most important constraints to aquaculture businesses are regulatory requirements, and access to financial support and research, amongst other aspects. The study also ranked interventions to develop aquaculture, and mentioned that national policy, facilitation of financial support and training, as well as skills advancement prove to be of utmost significance.

The literature review demonstrates that previous research studies mainly focus on identifying challenges faced by the small-scale aquaculture and possible interventions or solutions to these challenges (Madibana *et al.,* 2020; DAFF, 2012; Operation Phakisa, 2014; Britz *et al.,* 2009; Rouhani et al., 2004, Phosa, 2018). However, the appropriateness and sufficiency of the support programmes and policies implemented by the government in endeavours to address these challenges and develop small-scale aquaculture are often ignored. Therefore, this study focused on assessing the

appropriateness and sufficiency of public support programmes in developing small-scale aquaculture in South Africa.

This study further investigated whether these programmes have delivered the intended outputs and achieved their expected outcomes. Conducting this study was imperative, as the results are expected to assist government and aquaculture stakeholders to determine whether the current policies and support programmes are appropriate and sufficient. The findings and recommendations of this study would also assist in informing appropriate interventions when formulating development policies and support programmes for small-scale aquaculture.

1.3 Objectives

The overall objective of this study was to assess the appropriateness and sufficiency of public support for small-scale aquaculture producers in Gauteng Province, South Africa.

The specific objectives were to:

a) investigate the challenges faced by small-scale aquaculture farmers;

b) determine whether the financial support available through the Aquaculture Development and Enhancement Programme (ADEP) is sufficient and appropriate for small-scale aquaculture;

c) investigate whether the skills development support services available through the Aquaculture Technology Demonstration Centre (ATDC) are sufficient and appropriate for small-scale aquaculture; and

d) benchmark the public support programmes for small-scale aquaculture farmers in South Africa against similar programmes in other countries.

1.4 Definition of key concepts

1.4.1 Aquaculture

‘‘Aquaculture’’ means the farming of aquatic organisms, including crocodiles, in controlled or selected aquatic environments (marine, brackish or freshwater), involving (a) a degree of human intervention in the rearing process to enhance production which may include propagation, breeding, regular stocking, feeding or protection from predators and harvesting of cultured aquatic organisms; and (b) individual or corporate ownership of the stock being farmed and includes ranching, but excludes stock enhancement” (DAFF, 2018a, p.6).

1.4.2 Small-scale aquaculture

Small-scale aquaculture is defined in South Africa as comprising producers who employ less than 10 employees and produce less than 20 tonnes of fish per annum, with the intention of making profit (DAFF, 2018a).

1.4.3 Commercial aquaculture

Commercial aquaculture comprises producers who undertake aquaculture operations with the main intention of generating profit, who operate on a larger scale than that of small-scale aquaculture producers (DAFF, 2018a).

1.4.4 Government financial incentives

Financial incentives include grants and loans at low interest offered by the government to businesses as a vital instrument for increasing competitiveness, stimulating investments, promoting the inclusivity of previously marginalised groups, and addressing previous discriminations or inequalities (Browne, 2021).

1.4.5 Skills development

Skills development refers to the productive competences and abilities learned or developed in various levels of learning and training. These abilities can be acquired in a formal (e.g. school), informal or workplace arrangement (Sida, 2018).

1.4.6 Appropriateness

The term ‘appropriateness’ refers to the quality of being suitable or proper in the circumstances (Oxford Dictionaries, 2023). The Evaluation Policy and Guidelines of Action Against Hunger (ACF) defines ‘relevance/appropriateness’ as interventions suitable to the requirements of both the donor and impacted population (ACF International, 2011).

1.4.7 Sufficiency

According to the Merriam Webster Dictionary (2023), the word ‘sufficiency’ is defined as enough to meet the needs of a situation or a proposed end. In the Oxford Dictionary (2023), the term ‘sufficiency’ is described as the condition or quality of being adequate or sufficient.

CHAPTER 2:

LITERATURE REVIEW

2.1 Introduction

The purpose of this chapter is to provide a review of and examine the existing literature on the status of aquaculture in the global, regional, and South African contexts. For the aquaculture sector in South Africa, a baseline analysis will be provided. Furthermore, a review will be made of the characteristics of the aquaculture producers' categories, which will also define the small-scale aquaculture producers in detail. Small-scale aquaculture faces unique challenges, which will be discussed at length in this chapter. The literature study further presents a review of the distribution of small-scale aquaculture farms in South Africa.

The chapter further provides an overview of the existing public support programmes available and accessible to small-scale aquaculture in South Africa. An analysis of each identified programme will be covered in this chapter, focusing on its mandate, objectives, application requirements and qualifying criteria, where applicable. A specific focus will also be placed on the policy framework for the sector, which will further investigate the ability of the framework to contribute towards small-scale aquaculture development. Furthermore, the chapter will include performance evaluation results, where available.

In addition to the above, the chapter will define in detail the terms "appropriateness" and "sufficiency", which are the subject of this research. It will examine how previous studies have measured the appropriateness and sufficiency of programmes and or interventions. These are some of the aspects that were studied to perform a comprehensive literature review for the study.

2.2 Status of aquaculture

In recent decades, technological advancements in wild capture fisheries have resulted in a rapid increase in the volumes caught per fisher, per year. Fish resources are predetermined by nature, resulting in a decrease in fish stocks (FAO, 2018). As the world population continues rising in numbers, the demand for food, including aquatic food, also surges. The fish stocks in the sea have been reduced and threatened due to overfishing and, therefore, will not sustain and meet the required increasing aquatic food demand (Rohana *et al*., 2009). Aquaculture presents a good opportunity to supplement supply to meet the increasing demand for aquatic food by the rising population (Rohana *et al*., 2009). Increasing global fisheries products are being farmed owing to the growing worldwide need for aquatic foods products (FAO, 2018). Aquaculture incorporates a variety of aquatic species and farming techniques, which lead to various social, economic, nutritional, and environmental outcomes (Gephart *et al*., 2020).

Globally, aquaculture is one of the fast-growing food-producing sectors (Rohana *et al.,* 2009). Aquaculture yields have increased with average annual growth rates of 10.8% globally in the 1980s and it is envisaged that the sector will remain a fast-growing food-producing sector when compared with other sectors. It is anticipated that 40% of the world's fish supply will come from aquaculture by 2020 (Enviro-Fish Africa, 2006). According to FAO (2022), on the basis of the assumptions used, total fisheries and aquaculture production is expected to expand further and reach 202 million tonnes in 2030. This major increase in the scale of aquaculture is anticipated to result from expected economic growth, increases in population, and fluctuating food behaviours (Ridler and Ridler, 2001). Experts in aquaculture have agreed that, with prevailing resources and advancements in technology, fish yields from the aquaculture sector could be sustainably increased (Brugère and Ridler, 2004). In most countries, fish supplies from wild fisheries are alleged to have totalled or nearly equalled the maximum maintainable yields (Brugère and Ridler*,* 2004).

2.2.1 Status of aquaculture globally

In the global context, capture fishery production has remained static since the end of the 1980s, and, as a result, aquaculture has remained an alternative source of fish products consumed by people (FAO, 2018). Aquaculture is a source of employment, income, foreign exchange, and protein in developing countries, where the world's output of 90% is produced (Hishamunda *et al.,* 2009). The level of per capita consumption of fisheries products has been 20 kilogrammes per year, and the FAO has envisaged that by 2030, a further 27 million tons of aquatic products would be required to sustain this level of fish consumption (FAO, 2016). In 2018, worldwide fish yields were projected to be 179 million tonnes, of which, aquaculture contributed 46% of production, accounting for 82 million tonnes, with the value of USD 250 billion (FAO, 2020). China has continued to be the leading and highest producer contributing towards the total global fish production, contributing 35% in 2018 (FAO, 2020).

Edwards (2013) has reported that between 70% and 80% of the role-players engaged in aquaculture globally are considered small-scale. The study further indicated that the small-scale aquaculture (SSA) sector is known for its important contribution towards poverty alleviation and improving food security and socioeconomic development (Edwards, 2013).

In countries where the government has assisted in making local aquaculture producers more competitive, both domestically and globally, their sectors experienced rapid growth and expansion (DAFF, 2013b). In South-East Asia, where small-scale aquaculture is both dominant and successful, extensive support systems have been provided by governments and non-governmental organisations (NGOs), as well as development institutions (Kwasek *et al.,* 2015), to realise the sub-sector's potential to enhance food supply, alleviate poverty, enhance the development of economy, and expand livelihoods. However, Brugère and Ridler (2004) have argued that, in Asia, where aquaculture contributes approximately 89% of global aquaculture production, aquaculture growth was attributable

to the fact that it was commercially focused, and profited from an advantageous environment, coupled with sound government policies. In recent years, Asia continues to being the main producer, in 2020 representing 91.6% of global production (and 85% of value) (Mair *et al.,* 2023).

Traditionally, aquaculture in China has been household-based on a small-scale, and it was intended to provide for the sustenance of household families. Owing to high demand, aquaculture production transited to a market-driven economy in the fall of 1970s (Farquhar *et al*., 2017). At that time, technology and science progression were strongly supported by the government, which assisted the sector to graduate to commercial or large-scale production (Farquhar *et al.,* 2017).

2.2.2 Status of aquaculture in Africa

Africa contributed approximately 0.6% of global production by producing about 185 817 tonnes of fish, as well as other aquatic products, in 1998 (FAO, 1998). Brugère and Ridler (2004) mention that, owing to the existing resources and advancement in technology in Africa, it is well situated to become a part of aquaculture expansion. He reported that, with regard to resources, Africa has large inner continent waterways, with larger water bodies that cover 520,000 km^2. Of this area, approximately 43% of the continent evaluated could be suitable for farming African catfish, carp and tilapia. The author further shows that, in Southern Africa, almost 23% of the land area has potential for commercial African catfish and tilapia farming, with less than 5% of this land being utilised (Brugère and Ridler, 2004; Aguilar-Manjarrez and Nath, 1998). This shows how resources are not being used to their full potential, and are underused on the Continent.

A number of countries in Africa introduced aquaculture in the 1901 (Hecht *et al*., 2006). In terms of the current state of Africa's aquaculture, the continent's input to the global total aquaculture production remains small (Halwart, 2020). Aquaculture production on the continent has steadily improved over the years, but growth is slow (Hinrichsen *et al*., 2022). According to the FAO, aquaculture only contributed 16% to 18% of the regional total fish production in 2018 in Africa (FAO, 2020). This means the captured fisheries contributed about 82% towards the total fish production in the region. In terms of world aquaculture production, Africa's contribution has remained insignificant, with only 2196 million tons, accounting for 2.67 percent, in 2018 (Halwart, 2020). The leading producers in Africa – Uganda, Nigeria and Egypt – collectively contribute approximately 90% of total aquaculture production on the continent (Babatunde *et al*., 2020).

On the continent, Egypt is a leading producer, followed by Nigeria, in terms of aquaculture production in Africa. According to Kaleem and Abudou-Fadel (2021), the aquaculture industries in these two countries show success due to factors such as the high demand for fish, the existence of water sources, and institutional commitment. This shows that aquaculture development not only depends on government support, but also other external factors that contribute, such as demand for fish and the availability of resources.

In terms of Sub-Saharan Africa, most of these countries practise some form of aquaculture, mainly at very low production levels. Aquaculture in the Sub-Saharan Africa region is dominated by Nigeria as the leading producer, followed by Madagascar and Zambia (Machena and Moehl, 2001). In the early 1900s, when aquaculture activities were initially introduced by colonial governments, countries in Eastern Africa implemented and repeated policies and programmes with the intention of growing aquaculture, however, these proved unsuccessful (Mwanja and Nyandat, 2013).

Aquaculture is also included in the Southern African Development Community (SADC) fisheries protocol. This protocol constitutes a beneficial roadmap for national- and regional-level policy planners and policy makers. Enviro-Fish Africa (2006) reported that the SADC protocol mainly focused on development, and requires the public sector to consider and endorse aquaculture as a separate sector, so that it might optimise its economic contribution.

2.2.3 Status of aquaculture in South Africa

Aquaculture development in South Africa was introduced by the colonial government when they developed provincial hatcheries to stock fishing waters with nonindigenous fish species, such as trout and bass. Subsequent to this, in order to promote aquaculture for food security, a succession of hatcheries and grow-out facilities were constructed in the 1980s in the former homelands such as Venda, Lebowa, Gazankulu and Transkei (Rouhani and Britz, 2004). During this time, commercial aquaculture was established mainly to produce trout, catfish and ornamental species, amongst others. After 1994, a few small-scale commercial aquaculture projects were introduced to promote emerging farmers and black economic empowerment (Rouhani *et al*., 2004).

Fisheries are recognised as a sector with various strategic responsibilities in terms of job creation potential, food security, agrarian transformation and rural development, and with strategic links to beneficiation opportunities (APAP, 2012). South Africa has two fisheries categories; being the capture fisheries and the aquaculture sector (DAFF, 2014).

The aquaculture sector has become important in South Africa, owing to the worldwide demand for fisheries products, which has grown in recent years (DAFF, 2012). Adding to the APAP, the sector has been prioritised in the government's Industrial Policy Action Plan (IPAP) (DAFF, 2013). According to *Operation Phakisa: Oceans Economy*, South Africa has a wealth of marine and freshwater resources, and for this reason, and due to diminishing fish stocks in the water resources, as well as the growing need for fish, South Africa's aquaculture sector is said to have a high growth potential (Operation Phakisa, 2014). The sector provides significant potential for food supply, employment creation, economic development, rural development and poverty reduction, especially for the marginalised communities in coastal areas (AgriSETA, 2021).

Adding to its potential for enhancing economic development, South Africa's diverse climatic conditions allow for aquaculture production of different species to occur in several areas, depending on multiple factors such as weather conditions, temperature, and water quality. The most significant regions for freshwater aquaculture production, other than the coastal provinces, are in Mpumalanga and Limpopo (DAFF, 2017a). Some aquaculture production also takes place in the Northern Cape.

The aquaculture sector in the country is separated into two subsectors, namely Freshwater Aquaculture and Marine Aquaculture (DAFF 2017a). The main freshwater aquaculture species farmed in the country include Catfish (*Clarias gariepinus*), Carp (*Cyprinus Carpio*), Marron Crayfish (*Cherax tenuimanus*), Tilapia (*Oreochromis mossambicus Oreochromis niloticus* and *Oreochromis rendalli)*, Trout (*Onchorynchus mykiss* and *Salmo trutta*), Whiteleg Shrimp (*Litopenaeus vannamei*) and a number of ornamental species (DAFF, 2015). The main marine aquaculture species cultured in the country include Abalone (*Haliotis midae*), Dusky Kob (*Argyrosomus japonicus*), Mussels (*Mytilus galloprovincialis and Chromomytilus meridionalis*), Pacific Oyster (*Crassostrea gigas*) and seaweed (Ulva spp. and Gracilaria spp.) (DAFF, 2015). According to DAFF (2017a), the marine aquaculture sector is fast developing in the country and occurs along the coastal regions of the Eastern Cape, Western Cape and Northern Cape. Freshwater aquaculture is underdeveloped, and is dispersed around the country, occurring in all nine (9) provinces.

South Africa remains an insignificant contributor to both global and regional aquaculture production (Operation Phakisa, 2014). According to Babatunde *et al.* (2020), South Africa produced 6181 tonnes in 2018, contributing only 0.28 percent to the regional share. Operation Phakisa (2014) has reported that the coastal resources are not being used to their potential and to confirm this, compared countries with similar coastlines with South Africa. South Africa is reported to be contributing only 0.0003% of the global production, whereas countries with a similar coastline length produce more than 100 times the amount. These countries include Egypt and Thailand, each with coastlines of 2,450 km and 3,219 km that contribute 1.5% and 1.9%, respectively, to total global aquaculture production (Operation Phakisa, 2014).

In 2016, total aquaculture production was at 5 418 tonnes, with 66% derived from marine and 34% from freshwater aquaculture, representing about 0.8% of the entire total fisheries produced in the country. Furthermore, most of the farms, amounting to 23%, were situated in Western Cape in 2015. According to Britz *et al.* (2009), most of the aquaculture operations (76%) were small-scale operations, with turnover below R5 million. Larger operations, with revenue above R5 million, were mostly marine operations, farming abalone. With regard to provincial spread, the larger operations were situated in the Western Cape, whereas small-scale operations are evenly spread in all provinces (Britz *et al.,* 2009).

The DFFE (2019a) confirmed the report by Britz *et al*. (2009) and stated that a total of 229 aquaculture farms were operating in 2018, with 39 of the farms cultivating marine species and 190 farms cultivating

freshwater species. Both Britz *et al*. (2009) and DFFE (2019a) ascertained that freshwater aquaculture is mostly cultivated on a small-scale. Aquaculture species farmed on a small-scale include Carp (*Cyprinus Carpio*), Catfish (*Clarias gariepinus*), Marron Crayfish (*Cherax tenuimanus*), Tilapia (*Oreochromis mossambicus, Oreochromis niloticus* and *Oreochromis rendalli*), and a number of ornamental species. (DAFF, 2016). The 190 farms consisted of 39 farms recorded in Gauteng and Western Cape, followed by Mpumalanga with 28 farms, Limpopo (24), North West (21), KwaZulu-Natal (18), Eastern Cape (10), Free State (8) and the Northern Cape (3) (DFFE, 2019a).

2.3 Aquaculture producer categories

The definition of aquaculture includes aquatic organisms farmed/harvested by an individual or corporate body and owned by them throughout their nurturing process. In contrast, aquatic organisms exploitable by the public as common property resources, with or without appropriate licences, are referred to as captured fisheries. As mentioned, aquaculture involves individual or entity ownership of farmed fish. It is clear that the definition presents and introduces a social criterion or producer category that owns and provides ownership of the stock throughout its growth period, which differentiates aquaculture from captured fisheries.

Moehl *et al*. (2004) have stated that it is always difficult to categorise aquaculture farmers and actual farming operations according to comparative sizes, level of finance invested, and revenue aspirations. In South Africa, there are three distinct types of aquaculture producers, namely: commercial, small-scale, and subsistence producers (DAFF, 2018a). While this study focuses on small-scale aquaculture, this section will describe each producer category characteristics, however, more attention will be given to small-scale aquaculture challenges.

2.3.1 Commercial aquaculture

Commercial aquaculture comprises producers who undertake aquaculture operations with the main intention of generating profit, and their operations are larger than those operating on a small scale are (DAFF, 2018a). Hishamunda (2006) refers to commercial aquaculture as profit-oriented, and a category of producers who produce protein and provide rural employment and income. Brugère and Ridler (2004) defined aquaculture on a commercial scale as including operations with profit maximisation intentions, where revenues minus costs produce profits. Therefore, commercial aquaculture refers to farming activities in which the output is entirely for sale. The authors further indicated that an aquaculture commercial operation is not a substitute for rural aquaculture, but a counterpart. Law Insider Dictionary (2023) defines commercial aquaculture as the cultivation of aquatic plants and animals for sale and excludes subsistence production and personal consumption of aquaculture products. All authors agree that commercial aquaculture is orientated towards profit maximisation.

Commercial aquaculture operations are able to access finance from financial institutions for capital procurement, as they are able to provide collateral security. Owners and shareholders might also be able to provide capital as equity, instead of using credit from the bank (Brugère and Ridler, 2004). Furthermore, commercial farms often hire labour and are required to buy production inputs in bulk and to trade their products outside the farm (Brugère and Ridler, 2004).

Commercial aquaculture can generate taxes for the government and positively contribute to foreign exchange earnings, with added benefits such as improving economic efficiencies and competitiveness regarding aquatic products. Commercial aquaculture production is a complex business, necessitating various skills (Durborow, 2019). This is also the case in South Africa, and AgriSETA (2021) has indicated that aquaculture is a sector that is technical and difficult to enter owing to the skills required for a successful operation. For this reason, there are few commercial farms that are sophisticated and require technology and technical expertise in South Africa. Britz *et al.* (2009) and DFFE (2019a) agree with AgriSETA, noting that there are few commercial farms in the South African context when compared with small-scale operations. These farms mainly produce high-value species, such as trout, oysters, abalone, mussels and kob. As mentioned earlier, commercial aquaculture is mainly found in the Western Cape in terms of geographical distribution (Britz *et al.,* 2009).

2.3.2 Subsistence aquaculture

The production in subsistence or self-consumption farming is intended for the fish farmer's family to consume. Under this group, producers employ extensive techniques (Fermon, 2008). According to Law Insider Dictionary (2023), subsistence aquaculture comprises fish farming conducted primarily for the farmer's and their household's food needs and to support their lifestyles by producing fish for trade or sale rather than for financial gain. According to Akinrotimi, Abu and Aranyo (2011), subsistence aquaculture entails small-scale fish farming in inland and coastal regions, carried out by small households, primarily using semi-intensive and extensive systems, mostly aimed at their own use and revenue production. The primary goals of subsistence aquaculture, mostly found in rural regions, are survival and improving household living standards, rather than financial gain (Akinrotimi *et al*., 2011). Blanc (2021) has meanwhile referred to subsistence aquaculture as 'backyard' fish farming in a family pond.

Blanc (2021) states that subsistence aquaculture has similarities with small-scale aquaculture, as it is merged into other small-scale processes of family or community farms, but on a smaller scale, noting that it is technically simpler, and production is only used for family or community consumption. In the context of much of Africa, across a large portion of the continent, small-scale operations are often associated with 'subsistence', meaning that the operations are not conducted as businesses, although some produce may be purchased or sold (Mwanja and Nyandat, 2013).

Subsistence-level aquaculture is characterised by poor technology levels, productivity, and low material and management input (Madamba, 1979). Blanc (2021) agrees that subsistence aquaculture is characterised by practically no investment in infrastructure and grow-out technology and activities. Subsistence aquaculture often involves low-density stocking of juvenile aquatic organisms in backyard ponds or community-owned bodies of water, such as dams or natural ponds.

The subsistence aquaculture farmers do not own a hatchery and, therefore, may harvest fingerlings from the wild or purchase juvenile and fish seed from a local hatchery for grow-out purposes. Fermon (2008) indicates that subsistence farmers collect animal material, such as larvae, juveniles or sub-adults, in the wild and grow them in captivity by means of farming methods until such time that the fish reach a marketable size. Thus, subsistence aquaculture mostly constitutes fish farming that depends on extant fisheries. No supplementary feeds are provided and the farmers rely mainly on natural feed production of the pond or pens. Because of this, the output is very small, and the growth rate is very slow (Blanc, 2021). Harvesting is mainly done on a continuous basis, where produce is consumed by the farming household or the direct local community. As a result of these characteristics, subsistence aquaculture is a farming category that provides insufficient economic return (Madamba, 1979).

Small-scale, subsistence aquaculture is regularly conducted in the majority of developing nations (Madamba, 1979). Fermon (2008) notes that most small fish farmers in Sub-Saharan Africa use subsistence aquaculture techniques, which include low-input fish farming. It is said that small-scale and subsistence aquaculture requires sufficient institutional support and government attention, due to the fact that it has the potential to be significantly improved, thereby creating jobs for rural impoverished people, and can provide a vital source of protein for those people living in poverty (Madamba, 1979).

For South Africa, subsistence aquaculture refers to those producers who run their operations primarily for the purpose of feeding themselves and their families, and supporting themselves by selling or trading their aquaculture products, but not primarily for financial gain (DAFF, 2018a).

2.3.3 Small-scale aquaculture

In simplified terms, small-scale aquaculture is defined as “low input, low-output fish farming (Shrestha, and Pant, 2012), whereas commercial or large scale referred to as high-input, industrial fish culture.” A study by Edwards (2013) recognises the difference amongst modern and traditional aquaculture, and provided a number of prevailing definitions of small-scale aquaculture. It further shows that there are other existing terms for small-scale aquaculture, such as: (i) ‘artisanal aquaculture’; (ii) ‘urban aquaculture’; and (iii) ‘rural aquaculture’, whereas ‘small-scale aquaculture’ is the most recent term used (Edwards, 2013). The term ‘rural aquaculture’ remains commonly used, although ‘small-scale aquaculture’ (SSA) is more commonly used (Edwards, 2013). This provides evidence confirming that many authors and experts in the field use such terms interchangeably when referring to small-scale aquaculture. These terms are characterised by common elements, which include: ownership,

ownership by family or community, access, aquatic sources; and being of comparatively small size. The following sections will show how different authors have defined small-scale aquaculture and, lastly, how South Africa defines small-scale aquaculture.

Brugère and Ridler (2004) have noted that there is no generally accepted meaning of rural aquaculture. Rural aquaculture denotes the “poorest of the poor” and consists of very low inputs/very low output, where the farmer consumes all or almost all of the output. On the other hand, with regard to “less poor” aquaculture, which applies low/medium inputs, low/medium output, nearly all production is traded for income. Brugère and Ridler (2004) further agree with Edwards (2013), noting that ‘small-scale aquaculture’ is regularly used interchangeably with terms such as ‘rural aquaculture’ and ‘artisanal aquaculture’.

Harrison (1997) states that many operators conduct small-scale aquaculture as a secondary activity, and a not primary activity, which is used to supplement income, provide a source of extra food, and also as a diversification strategy. Furthermore, this category may be combined with other aspects of farming, such as livestock and crop farming, while benefiting each other. Small-scale farming households, who farm fish by using semi-intensive or extensive lower-cost farming technologies appropriate to their resource base, are referred to as conducting small-scale rural aquaculture.

It is acknowledged that the small-scale aquaculture (SSA) industry significantly contributes to socioeconomic development, poverty alleviation, and food security (Edwards, 2013). The Asian aquaculture sector provides proof that small-scale aquaculture does contribute positively towards developmental goals. The Asian aquaculture sector continues to dominate global production and it is predominantly conducted at a small scale.

According to the DAFF (2018a), small-scale aquaculture in South Africa is defined as comprising those operations that employ fewer than ten people, produce less than twenty tons of fish annually, and do so with the intention of generating a profit. In South Africa’s rural areas, this group of producers could support food security, economic growth, and higher aquaculture productivity. It is evident that South Africa defines small-scale aquaculture in terms of production scale per annum, number of personnel employed, and the primary driving force behind farming – profit – in contrast to other research studies that restrict the definition to rural aquaculture. It is also apparent that the goal of small-scale aquaculture is to generate income and support local economic growth rather than only to employ family members. This agrees with Mwanja and Nyandat (2013), who indicated that, in some regions in Africa, “small-scale” producers are entrepreneurs, where “small” refers mostly to the size of the operation, while it functions as a regular farm business.

2.3.3.1 Characteristics of small-scale aquaculture

A simplified characterisation of small-scale aquaculture was adopted by the NACA-ASEAN Foundation Project on Promoting the Competitiveness and Sustainability of Small Holder Aquaculture Farmers (Bondad-Reantaso and Prein, 2009). Small-scale aquaculture was defined as comprising family-run businesses with a focus on employing family members, frequently operating on the land owned by the family, and with limited land and water area. They were also perceived as being vulnerable. Similarly, Harrison (1997) noted that small-scale aquaculture typically consists of one small production unit, either family-run or operated by an individual, with minimal input levels and little to no outside help.

Sen *et al*. (1996) state that the cultivation of fish in earthen ponds, with substantial or semi-intensive management, is known as small-scale aquaculture in Eastern and Southern Africa. For the nations in these regions, small-scale aquaculture is typically a part-time endeavour that shares many resources with other agricultural and animal husbandry endeavours and is typically integrated with them.

Brugère and Ridler (2004) distinguish between commercial and rural aquaculture (non-commercial aquaculture) to note that, if aquaculture is viewed as a variation of economic activities from those that are solely focused towards sale and those wholly focused on self-use, the percentage of the output that is sold or consumed determines the classification. Nevertheless, Brugère and Ridler (2004) go on to say that rural aquaculture producers might be able to trade all of their fish and earn a profit. Although the farmers frequently view fish as a cash crop, the purpose of rural aquaculture is directed towards diversifying crops in order to reduce risks and less for maximising earnings. This makes it evident that small-scale aquaculture is orientated towards self-consumption, rather than profit maximisation. Small-scale aquaculture depends mainly on the presence or nonexistence of business intentions (Harrison, 1997). This is not the case in South Africa, where small-scale aquaculture is defined as producing with the goal of generating profit.

Small-scale farms are generally family farms that depend on domestic labour (Brugère and Ridler, 2004). Bondad-Reantaso (2009) concur that family labour is typically the foundation of small-scale aquaculture. Small-scale farming households typically employ only family members to carry out farming tasks. The daily management of extensive and semi-intensive aquaculture production systems does not require much domestic labour (Sen *et al.*, 1996). Munthali *et al.* (2022) notes that, in Malawi, the source of funds for most small-scale aquaculture farmers starting their farming operations was mostly derived from family savings, and that none of the farmers under study had started their farming operations with funding from financial institutions.

Small-scale aquaculture can be extensive or semi-intensive (Sen *et al.,* 1996). According to Ling *et al*. (1999), extensive or semi-intensive aquaculture systems are typically used in small-scale aquaculture from a biotechnical standpoint. Inputs are applied to the production process in the extensive or semi-intensive system. According to Sen *et al.* (1996), the ability of extensive systems to produce natural food is what makes them work, and they may be made better by adding small amounts of organic

fertilisers. The natural food in semi-intensive systems is still taken into consideration, but it is improved by adding more fertiliser and feeds as supplements. Because these farmers do not rely more on purchased inputs, their small-scale aquaculture farms can be located in rural areas, and the surplus output not used by the farming household is often traded to nearby communities (Brugère and Ridler, 2004).

Limited amounts of capital and operating expenses, mostly derived from family labour, are invested in small-scale aquaculture, which is undertaken by one or a few businesses (FAO, 2018). Sen *et al.* (1996) concur that small-scale aquaculture requires modest funding, primarily for the purchasing of fingerlings and possibly for the building of ponds.

Extension services are necessary for the capacity development of human resources, as knowledge, technology, and skills are required in the aquaculture industry (FAO, 2017). According to Sen et al. (1996), aquaculture extension services are typically organised in a hierarchical and compact manner. Aquaculturists, technicians and field workers are among the extension agents available. Extension agents have to contact many dispersed small-scale producers in many African countries, which makes their work difficult due to a lack of staff and funding, as well as the dispersed localities of farmers (Sen *et al.,* 1996). Because of this, small-scale producers struggle to obtain information, especially about markets, and have little technical experience (Brugère and Ridler, 2004).

Munthali *et al.* (2022) emphasised the importance of education, pointing out that literate farmers are more likely to absorb and apply innovations, technology, and new and improved aquaculture management techniques. Due to its relative novelty in Southern and Eastern Africa, small-scale aquaculture has experienced issues akin to those encountered by other emerging agricultural technologies. According to production data, small-scale aquaculture in southern and eastern Africa is characterised by subpar productivity, a propensity for pond abandonment or bad management, low rates of enhanced technology adoption, and poorly sustainable aquaculture enterprises (Harrison *et al*., 1994).

2.3.3.2 Challenges faced by small-scale aquaculture

The previous sections of this chapter discussed in detail different types of aquaculture producer categories. Because of their different characteristics, these producers experience different challenges that could hinder their growth and development. This section discusses the challenges faced by small-scale aquaculture.

Absence of fish feed, poor quality extension services, or inadequate information, poverty, and low-quality fish seed are among the typical issues that small-scale aquaculture faces worldwide (Mwanja and Nyandat, 2013). After conducting a survey in Malawi, Munthali *et al.* (2022) came to the conclusion that the main issues facing small-scale aquaculture in Malawi were: lack of availability of land to build

ponds; lack of fishing equipment; absence of high-quality feed; fish diseases; adverse environmental conditions for the production of fish; a lack of well-organised markets; lower revenue; poor quality fingerlings; high costs of labour; lack of funding; and lack of pertinent extension support. Figure 2.1 shows the commonly cited challenges that hindered the production of fish in Malawi.

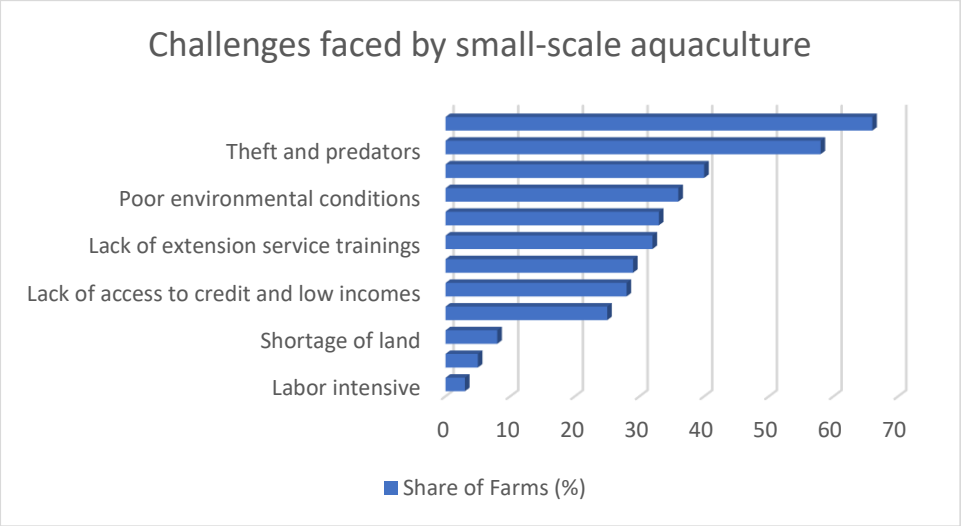


Figure 2.1: Challenges faced by small-scale aquaculture in Malawi

Source: Munthali *et al.* (2022)

A number of obstacles to the growth of the aquaculture industry in South Africa have been recognised by the NASF and the Operation Phakisa Aquaculture Lab. Among the difficulties are a lack of adequate fundamental infrastructure, difficulty in obtaining high-quality inputs, disjointed R&D, difficulty in obtaining funding, an unfavourable legal and regulatory landscape, and restricted market accessibility. According to a research study by Madibana *et al.* (2020), which aimed to emphasise the difficulties faced by start-up farmers in aquaculture, the latter is accurate. According to the study, one of the main reasons why aquaculture is not progressing as it should in South Africa is the lack of access to essential resources like land and water, as well as to funding.

a) Lack of access to funding

Small-scale aquaculture farmers lack access to funding because of the credibility and collateral required for them to gain access to formal credit (European Commission, 2017). Generally, aquaculture requires high capital investment, and it also takes longer for investors to realise their return on investments (Operation Phakisa, 2014). The capital-intensive nature of aquaculture presents a distinct set of risks (Basu, 2019). Aquaculture is not only a capital-intensive industry, but is also technology-driven. Moreover, enterprises engaged in aquaculture encounter the added obstacle of attracting capital to a comparatively emerging industry (Basu, 2019). Aquaculture necessitates highly skilled labour and know-how due to being capital-intensive and technological in nature (Njokweni, 2015). Furthermore, high capital investments in terms of species development and machinery are required for a successful

aquaculture. This becomes a barrier to development, since, as stated by Van Duijn *et al*. (2018), the two main issues facing all fish producers are the high costs of inputs like feed and fingerlings and the difficulty in obtaining loans. According to a survey conducted in South Africa by Britz *et al*. (2009), access to funding and regulatory requirements are the largest obstacles to the growth of aquaculture enterprises, among other things. Operation Phakisa (2014) further emphasises how difficult it is for aquaculture farmers to obtain financing, where the industry is still in its infancy, and is seen by financial institutions as presenting a high degree of risk. Several private financiers are doubtful about providing finance to a sector that is still striving to strengthen its position in the country's agricultural sector (Madibana *et al.,* 2020).

b) Regulatory barriers

Britz *et al.* (2009) reported that one of the most important constraints to aquaculture enterprise development comprises regulatory requirements. One of the biggest obstacles facing aspiring aquaculture producers is the absence of laws and regulations that support them in South Africa (Madibana *et al.,* 2020). Phosa (2018) noted that the sector at the time of the study had uncoordinated legislative provisions and it was overregulated, which hindered the development of small-scale aquaculture farmers in the country. The Operation Phakisa Aquaculture Lab report (2014) states that, in order to formalise the intention to operate an aquaculture farm, the potential farmer would then need to apply for 28 permits and licenses, which are costly to obtain. The process to obtain the authorisations is also lengthy and can take up to three (3) years (1100 days) (Operation Phakisa, 2014). The aquaculture sector is regulated more than other food producing sectors are (DAFF, 2013a). These permits and licenses are obtained through and issued by a large number of different government departments and authorities (CSIR, 2019). This shows how complicated and complex it is to formalise and operate an aquaculture farm.

c) Lack of skills development and training

Rouhani and Britz (2004) carried out a baseline investigation on the role that aquaculture plays in South Africa's rural livelihoods. The study came to the conclusion that aquaculture was then not underdeveloped because of the unavailability of land, water, or infrastructure. However, despite efforts to boost the rural aquaculture industry, projects that did not receive continuous technical support had failed. This shows that inadequate human resources for aquaculture management, research, and advisory and technical services comprise one area that hampers the sector's development in South Africa (FAO, 2018). The Operation Phakisa Aquaculture Lab Report stated that, because the sector is still new, there is a limited extension support provided. It further stated that the research and development for aquaculture is fragmented and uncoordinated, and is often not aligned with the sector's needs (Operation Phakisa, 2014). Madibana *et al.* (2020) performed a study revealing that, while South Africa has a robust financial system and institutions capable of providing financial support to enterprises, these institutions lack the necessary technical expertise to assess business plans related to

aquaculture. On another hand, aquaculture is a technology-driven sector (DAFF, 2013b), where, for this reason, it might be challenging for inexperienced farmers to operate or compete in the industry.

d) Lack of access to land and sea space

The Operation Phakisa Aquaculture Lab Report (2014) also identified access to land and sea space as a challenge. Madibana *et al.* (2020) found that aquaculture, as for other farming activities, requires land, and that without land, the emerging farmers would have restricted roles within aquaculture development. Operation Phakisa (2014) also mentions that challenges in terms of access to sea space and land could be attributable to fact that aquaculture is often excluded from spatial planning and is more often not prioritised. According to Njokweni (2015), the aquaculture industry faces a number of difficulties, such as poorly coordinated institutional structures, difficulties in finding a suitable location for aquaculture farming, high production costs, restricted access to suitable waters, sea space and land, a lack of government support for farmer development, and a lack of suitable technology. Aquaculture development that supports rural economic development and food security would not be feasible or sustainable if these issues are not resolved.

These challenges prevent small-scale aquaculture from growing and from contributing significantly to the sector's development. According to Njokweni (2015), the government needs to put in place the appropriate institutional framework for using aquaculture as a means to achieve its goals for job creation, improved food security, and poverty reduction. In order to support rural aquaculture in South Africa, national policy, financing accessibility, and the promotion of training and skills development are the three most crucial interventions that must be made (Britz *et al.,* 2009). Phosa (2018) concurred that small-scale aquaculture would be able to contribute to revenue generation of rural communities if given support such as enhanced finance access and local feed production.

2.4 Public support programmes for smallholder aquaculture farmers in South Africa

This section provides an indication of the existing public support programmes available and accessible to small-scale aquaculture in South Africa. An analysis of each identified programme will be covered under this section, focusing on its mandate, objectives, application requirements and qualifying criteria, where applicable. Specific attention will be given to the policy framework for the sector and will further investigate their ability to contribute towards small-scale aquaculture development. Furthermore, the chapter will later include performance evaluation results for the programmes, where available.

As with most other nations, South Africa's aquaculture industry is subject to a number of directives from national, provincial, and local government agencies that either directly affect the industry or have some bearing on it. As a result, a variety of important role-players influence and aid in the development of aquaculture in the country. The primary actors in the development of aquaculture are the government authorities at the national, provincial, and local levels (DAFF, 2013c). The national government sets

policies for aquaculture, develops frameworks and strategies, and puts in place the legal and institutional framework for implementation and research. Table 2.1 shows the various government departments involved in aquaculture, and gives a summary of their competencies.

According to the DAFF (2013c), aquaculture is governed by several governmental departments. In 2009, the DAFF was designated as the principal organisation for the management of aquaculture (DAFF, 2013a). The Department of Environmental Affairs (DEA) works to establish an environment that will allow for the growth of a more maintainable aquaculture industry, while the Department of Agriculture and Fisheries (DAFF) offers strategic direction for the industry's growth (Phosa, 2018). However, in 2019, the new government administration implemented a restructuring of government Departments. This resulted in the Forestry and Fisheries Branch of the former DAFF being amalgamated with the Department of Environment to form the new Department of Forestry, Fisheries and the Environmental (DFFE). Therefore, currently, the DFFE plays a significant role as a lead department, providing strategic management regulating and creating sustainable aquaculture.

In addition to coordinating national project activities, the provincial government provides technical assistance to farmers. DAFF (2013c) states that provincial departments alone possess the authority to handle matters such as veterinary care and waste removal. Municipalities and local governments have a vital influence on the growth of aquaculture. According to DAFF (2013c), they are in charge of municipal planning, which includes zoning, building codes, and the supply of utilities like water, electricity, and solid waste disposal.

The Agricultural Research Council (ARC), which conducts research and disseminates technologies, is another important stakeholder. Aside from the World Wildlife Fund for Nature (WWF) and other non-governmental organisations (NGOs), additional stakeholders in South African aquaculture include community-based organisations (CBOs), tertiary institutions, and private businesses.

Table 2.1: National departments involved in aquaculture

NATIONAL DEPARTMENT	COMPETENCY
Department of Agriculture, Forestry and Fisheries	In charge of overseeing and assisting the country's forestry, fisheries, and agriculture industries, including aquaculture (including encouraging the industry's growth and granting permits and rights for marine aquaculture). Additionally, DAFF is in charge of making sure that everyone in the nation has access to sufficient food that is safe and nourishing.
Department of Environmental Affairs	Accountable for preserving, enhancing, and safeguarding South Africa's natural resources and environment. The department governs environmental authorisations and issues coastal waters discharge permits.
Department of Trade and Industry	Accountable for the industrial and commercial policies. In addition to enforcing commercial law, the department and its affiliated organisations work to advance economic growth, black economic empowerment, international trade regulation, and consumer protection.
Department of Public Works	In charge of advancing the country's Expanded Public Works Programme and fostering the transformation of South Africa's real estate and construction sectors.
Department of Rural Development and Land Reform	In charge of encouraging rural South Africa's social and economic development. The objective is to enhance agricultural output by means of the most efficient and sustainable utilisation of natural resources and suitable technologies, guaranteeing food security, respect, and enhanced rural livelihoods.
Department of Health	Accountable for preventing diseases in order to improve the state of health.
Department of Water Affairs	Accountable for formulating and carrying out the policies governing this industry, as well as for encouraging the effective and efficient management of water resources to guarantee sustainable social and economic development. It controls the licensing of water use and has ultimate authority over municipal government-provided water services.
Department of Science and Technology	Responsible to design, organise, and oversee a national innovation system that will maximise human capital, promote maintainable economic growth, and enhance quality of life for people.
South African Bureau of Standards	In charge of promoting and maintenance process, product, and service quality standardisation.
National Ports Authority	In charge of the marine services and port infrastructure at South Africa's eight commercial seaports.
National Regulator for Compulsory Specifications	Accountable to the Minister of Trade and Industry for enforcing technical rules, such as mandatory requirements derived from standards safeguarding the environment and public health and safety.

Source: DAFF (2013c)

The government has shown great commitment to the development of the agricultural sector in its entirety, as well as the development of aquaculture (DAFF, 2013a). As part of its obligation towards aquaculture, it has, over the years, established several initiatives, policies and programmes, and has conducted numerous research projects to address matters that hamper the progress and development of the aquaculture. As such, this section provides an assessment of the aquaculture programmes developed by the South African government.

There are various national policies and programmes that set out the government's objectives for achieving overall aquaculture growth and development. It is therefore essential to review these policies and programmes to assess their contributions to small-scale aquaculture development. Table 2.2 illustrates a number of interventions implemented in the country over the years, with the main objective of addressing the stumbling blocks in the way of aquaculture development.

Table 2.2: South Africa's government interventions to develop the aquaculture sector

YEAR	MAJOR GOVERNMENT INTERVENTIONS
2009	• Merging freshwater and marine aquaculture under one Department, the DAFF.
2010	• Formation of the Aquaculture and Economic Development Chief Directorate to oversee the aquaculture sector (Marine and Freshwater Aquaculture)
2011	• Inclusion of aquaculture in the Customised Sector Strategies Programme and IPAP
2012	• National Aquaculture Strategic Framework, 2012
2013	• Development of National Aquaculture Policy Framework, 2013 • Examination of institutional arrangements governing aquaculture and legislation. • Aquaculture Development and Enhancement Programme approved and launched.
2014	• Operation Phakisa – Oceans Economy (Aquaculture Lab)
2015	• Aquaculture Development Bill concept document (Gazetted)
2016	• Reviewed Aquaculture Development and Enhancement Programme • Draft Aquaculture Development Bill
2017	• Sector investment promotion
2018	• Sector investment promotion

Source: DFFE (2019a)

This section focuses on evaluating the government's objectives with regard to small-scale aquaculture through a policy review and analysis of some existing strategies and support programmes in the aquaculture sector. There are various national policies and programmes that set out the government's objectives for achieving small-scale aquaculture development. As indicated above, aquaculture has many role-players that impact on its growth and development. However, for the purpose of this study, the research will look into the policies and public programmes implemented on a national level. The government strategic documents and support programmes are examined in the following sub-sections.

2.4.1 National Aquaculture Strategic Framework for South Africa (NASF) (2012)

A National Aquaculture Strategy was identified to be necessary by the IPAP for advancing and expanding the aquaculture industry, according to DAFF (2012). As a result, the strategy was created in 2010, after lengthy discussions with stakeholders in the aquaculture industry, and was subsequently adopted in 2012. The strategy is regarded as a blueprint for the growth of aquaculture in the nation, since it offers guidelines to help public sector support of the industry's growth. Herbst (2013) asserts that the strategy was created as a government roadmap for the sustainable development of a thriving domestic aquaculture industry through cooperation between DAFF, the DTI, and industry stakeholders. Herbst (2013) adds that the framework offers a planned course for the creation of the aquaculture industry. The strategy indicated that, through its implementation, the overall aquaculture sector would expand over the following five years (2012–17) (DAFF, 2012).

It is apparent that the NASF was developed to offer a uniform national framework and scope for aquaculture development (DAFF, 2012). It was accordingly created with seven (7) objectives, being to:

- create a practical and adaptable strategy to address implementation flaws in aquaculture uptake;
- create transferable technologies that will make aquaculture economical for producers;
- provide jobs and opportunities to build wealth as a first priority;
- make the aquaculture industry profitable and competitive in the global marketplace in an economically and socially responsible manner, while ensuring that the necessary environmental services are secured, for which it is important to develop smarter dissemination strategies and transfer pertinent scientific and technical knowledge;
- assure change and strengthen social cohesiveness, putting young people first;
- giving national food sovereignty and seafood production top priority; and
- engaging in regional aquaculture development.

The strategy proved to be essential and effective for the sector, as in 2013, the NAPF was developed in response to the NASF to identify opportunities and address challenges associated with aquaculture

development (DAFF, 2013a). In addition to this, an incentive was developed by the Department of Trade and Industry, in collaboration with DAFF, in response to challenges with access to finance. The Aquaculture Development and Enhancement Programme (ADEP) was established in response to the NASF and offers cost-sharing grants to registered aquaculture operations, with the intention to stimulate investments in the sector (DAFF, 2013a).

The Marine Living Resource Fund (MLRF) Annual Report 2013/14 reported, amongst other things, that the implementation of NASF resulted in the establishment of several programmes supporting the aquaculture sector, which include the Finfish Monitoring and Control Programme (FM&CP), a food safety programme for aquaculture; the Public Understanding of Aquaculture Programme (PUA), an awareness programme developed in partnership with the aquaculture sector and the FAO; and the Aquatic Animal Health Strategic Framework (AAHSF), which focuses on the bio-security framework for aquaculture (DAFF, 2014).

It is evident that the NASF aims to provide a strategy to develop the overall aquaculture in the country and does not have any specific goals linked entirely to small-scale aquaculture development. However, the strategy does recognise the creation of aquaculture SMEs as one of its main outcomes. Similarly, providing funding for the development of aquaculture, particularly for small-scale aquaculture ventures, is one strategic way to advance the industry. Furthermore, it acknowledges that small- to medium-sized aquaculture businesses ought to cater to local, regional, and global markets, and mentions that large aquaculture companies should take the lead in assisting small-scale aquaculture businesses with training.

2.4.2 National Aquaculture Policy Framework (NAPF) (2013)

One of the main pillars for accomplishing the goals of the National Development Plan (2030) and the New Growth Path (2020) is the National Aquaculture Policy Framework (DAFF, 2013a). In order to identify possibilities and address issues related to aquaculture development, the policy was created in response to NASF (DAFF, 2013a). Government's medium- and long-term strategies for reducing poverty, unemployment, and inequality were taken into account by the NAPF (Halley, 2019).

The following elements were identified by the NAPF as being approaches linked to small-scale aquaculture development:

- The strategy acknowledged that the public sector may need to provide early support for small-scale aquaculture growth and stated that aquaculture would be incorporated into larger programmes for rural development in order to accomplish this.
- In terms of human resources development, the policy indicates that small-scale farmers need access to trained aquaculture extension officers, technicians and scientists.

- According to the policy, aquaculture is capital intensive, and because of this, SMMEs may potentially find it difficult to operate because of their struggles in accessing funds.
- The policy placed emphasis on the necessity for developing hatcheries in order to develop small-scale aquaculture, as this will facilitate the supply of seeds.

In conclusion, the NAPF aims to address constraints and propose certain actions. The policy recognises the need to assist the commercial and small-scale farmers equally, and has several priority areas, including support for aquaculture development. It is clear that the policy does recognise and acknowledges small-scale aquaculture and its current challenges, and does propose interventions to address the identified issues.

2.4.3 Aquaculture Development and Enhancement Programme (ADEP)

Frank (1993) asserts that aquaculture requires a large amount of capital. Since aquaculture is stated to be a technology-driven sector, significant and ongoing capital investment is needed. Because of their restricted financial options, most aquaculture companies are unable to fund the kind of large-scale R&D projects that are necessary (DAFF, 2017a). Furthermore, organisations involved in aquaculture encounter the additional difficulty of attracting capital into a relatively new industry (Basu, 2019).

The risks and high start-up costs involved with aquaculture farms, a lack of market potential, a lack of infrastructure investment, and security risks are some of the recent problems confronting the industry. This also shows that further government assistance is still needed to reduce red tape and introduce finance programmes that benefit small-scale aquaculture, such as making doing business easier. Governments in nations where aquaculture has expanded in the past have given farmers financial support to increase their competitiveness on the domestic and global markets (DAFF, 2013b). Therefore, financial support from the government is essential to the growth of aquaculture.

According to the 2016/17 Annual Incentive Performance Report (AIPR) of the DTIC, aquaculture is among the strategic sectors supported by the government. In order to encourage investment within the aquaculture sector and grow emerging aquaculture farmers, the ADEP was launched in 2013 (DTI, 2013). The ADEP was introduced as a sector-specific incentive, aimed at aquaculture activities, covering primary, secondary and ancillary activities (DTI, 2016). In an effort to increase investment in the industry, the incentive programme, which is open to registered aquaculture firms, provides a reimbursable cost-sharing grant of up to a maximum of R40 million (DAFF, 2014). The ADEP was created in response to the NASF, and is administered by the DTI, as it existed at the time (DAFF, 2013a). According to the NASF, the government has prioritised providing an incentive for aquaculture, acknowledging the socio-economic prospects it offers for fulfilling essential constitutional objectives for a more just and equitable society (DAFF, 2016).

The programme was launched in 2013, and was amended in 2016. The guidelines of the programme set out in 2013, prior the amendments, stipulated the objectives of ADEP as being to stimulate investment in the aquaculture sector (DTI, 2013), with the intention of:

- increasing production;
- creating and/or sustaining jobs;
- promoting geographical distribution; and
- expanding participation.

The review of the programme in 2016 introduced additional benefits, and the changes described below were made.

The objectives of the programme were reviewed and changed to:

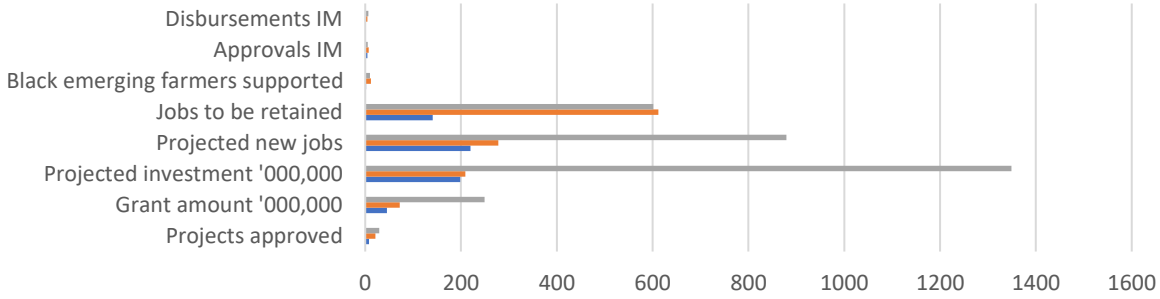
- develop emerging aquaculture farmers;
- increase production;
- create and sustain jobs; and
- promote geographical distribution.

In summary, the reviewed programme sought to develop emerging aquaculture farmers, support and generate employment opportunities for new aquaculture farmers, boost productivity, and promote regional variety (DTI, 2016). The guidelines further included a clause that focused on emerging black farmers, offering them a cost-sharing grant of up to 80%, while other applicants outside this category could qualify for up to 40%. Other costs covered, such as rental costs, environmental impact assessment (EIA) charges and mentorship costs, were limited to emerging black farmers. Other changes in 2016 included the grant maximum cap amount, which reduced from R40 million to R30 million (DTI, 2016).

It is notable that the main purpose of the review of the programme in 2016 was to make it more accommodating to emerging black farmers, therefore broadening participation in the sector. However, the 2016/17 Annual Incentive Performance Report shows that, during the 2016/17 financial year, the incentive experienced a decline in terms of the number of approvals and projected jobs, as well as in investments when compared with the 2015/16 financial year (DTI, 2017).

The quantity of incentive approvals climbed significantly over the 2017–18 fiscal year, rising by 60%, and a multiplier of 2,9 in investment was noted for the later year (DTI, 2018). The 2017/18 AIPR further reported that, of 21 approvals that were collectively approved for R47,1 million with an expected investment value of R121,3 million, all were Broad-Based Black Economic Empowerment (B-BBEE) Level Four, and 12 were emerging black farmers (DTI, 2018). The amended programme continued to

show positive contribution to the sector, as the 2018/19 Annual Incentive Report reported a further increase in the number of approvals, when compared with the 2016/17 and 2017/18 financial years. Twenty-nine (29) approvals were given to the approved amount of R248 million and projected investments of R1,3 billion. Figure 2.2 below shows the aggregate performance for the three (3) financial years.



	Projects approved	Grant amount '000,000	Projected investment '000,000	Projected new jobs	Jobs to be retained	Black emerging farmers supported	Approvals IM	Disbursements IM
2018/19	29	R249	R1 349	879	601	10	5,4	6,9
2017/18	21	R72	R209	278	612	12	7	4,3
2016/17	8	R45	R198	220	141	2	4,4	0

Figure 2.2: ADEP aggregate performance for 2016-2019

Source: DTI (2016); DTI (2017); DTI (2018) & DTIC (2019)

The report stated that support for emerging black farmers commenced in 2017/18 (DTI, 2018). It is clear from Figure 2.2 that the reviewed programme did achieve its objective of economic inclusion and increasing the participation of emerging black farmers.

In 2019, the programme underwent revisions and approval, notwithstanding its accomplishments. The aim was to guarantee that the programme would assist small black businesses, which would encourage greater participation and bring about transformation in the industry (SANEWS, 2019). Among the noticeable changes, the grant amount cap was reduced to R20 million. According to SANEWS (2019), the changes were informed by a rapid assessment of the programme, which was commissioned and concluded in 2018. The assessment and the recommendations played a pivotal role in the consultative engagements with pertinent stakeholders, such as DAFF, which ultimately resulted in the Minister's acceptance of the updated ADEP guidelines. Additional modifications to the programme under discussion included raising the maximum rental charges for small black businesses under the ADEP, from R10,000 to R20,000 per month, capping feed expenses at 20% (up from 10%), and the cap on mentorship was raised from R50,000 to R200,000, subject to approval.

The objective of the programme also changed as follows:

The objective of the incentive is to stimulate investment by commercially viable enterprises in the aquaculture sector (DTI, 2019, p. 5). The secondary objectives are to:

- Create and/or sustain jobs;
- Broaden participation;
- Increase production; and
- Geographical spread.

From its inception until 2019, the ADEP has been aggressively investing in the sector, with 89 projects totalling an estimated R2.197 billion in investment being approved. As a result, it is estimated that 2,377 employment opportunities were generated and maintained (SANEWS, 2019). The 2019/2020 Annual Incentive Report shows that in 2019/20 financial year, 13 projects totalling the grant amount of R49.6 million have been approved, with a corresponding project investment of R111.2 million (DTIC, 2020). This shows a decrease, when compared with the 29 projects approved during 2018/19 financial year. Of the 13 approved projects, seven were emerging black farmers.

From the information gathered and analysis conducted, it is clear that the programme has endeavoured to grow and develop small-scale farmers. The revised guidelines strongly assert the need to transform the sector and to ensure that small-scale black entrepreneurs would benefit from the programme. With the data collected for the two (2) financial years 2017/18 and 2018/19, when support for emerging black farmers commenced in 2017/18 (DTIC, 2018), it clear that the number of small-scale emerging farmers supported grew, and almost 57% and 34,5% of approvals in 2017/18 and 2018/19 financial years, respectively, were given to small-scale emerging farmers. The 2019/2020 Annual Incentive further reports that ADEP is broadening participation in the aquaculture industry.

The programme has focused not only on costs for infrastructure, machinery and equipment, amongst others, but also on costs, such as rental costs, aquaculture feed, environmental impact assessments (EIA) and permit authorisations and mentorship, which are only applicable and limited to small-scale black enterprises (DTIC, 2019).

2.4.4 Operation Phakisa: Oceans Economy (Aquaculture)

Apart from the programmes and policy frameworks that have been developed and implemented, the South African government has also developed and initiated an initiative known as Operation Phakisa (DAFF, 2017b), which is the most relevant novel initiative in terms of aquaculture (DFFE, 2016). The initiative seeks to execute important social and economic programmes in a higher quality and more efficient manner (Njokweni, 2015). The government established Operation Phakisa as a means for achieving more effective and efficient policy and programme implementation (National Treasury, 2015).

According to DFFE (2016), the focus of this initiative is to unlock the economic potential of the oceans in South Africa, which by 2033 may add approximately R177 billion to the country's Gross Domestic Product (GDP) and provide 800,000–1 million direct employment opportunities. There are forty-seven (47) comprehensive measures that, if implemented, would add R20 million to the GDP of the ocean economy and generate 22,000 new direct employment opportunities by 2019 (DFFE, 2016). Key stakeholders within the public, private and academia sectors, as well as civil society organisations, were brought together to work collectively and create strategies with clear milestones that would drive the growth of their specific sectors (Halley, 2019).

Aquaculture is one of the industries that Operation Phakisa prioritised in order to capitalise for enhancing the economic potential of the nation's oceans. Ocean governance, offshore oil and gas development, marine protection services, and marine transportation and manufacturing are other industries that have been given priority (Halley, 2019). In 2014, a planning session, known as the Aquaculture Lab, was established, comprising stakeholders from the industry, government, and academia. During this session, various challenges faced in promoting the growth of the sector were identified, and eight main initiatives, grouped into five principal categories, were developed to address the challenges (Operation Phakisa, 2014).

In summary, one of the eight key initiatives addressed the selection and implementation of catalytic aquaculture projects, where farms would be required to support Operation Phakisa's goals with regard to output, employment opportunities, and transformational impact. By the end of 2019, it was anticipated that these initiatives would increase the revenue of the aquaculture subsector from approximately half a billion rand to almost R1.4 billion (Mkhize and Mbhele, 2017). The establishment of an interdepartmental authorisation committee, a globally recognised monitoring and certification system, and legislative reform constituted three measures pertaining to the building of an enabling regulatory framework. The Aquaculture Development Fund, which is the 5th initiative, focuses on funding support, capacity building and skills development, and increasing the skills pool and awareness, whereas coordinated industry-wide marketing efforts and Government Preferential Procurement focuses on improving access to markets. The last initiative comprises Aquaculture Development Zones. Initiative seven (7) of the eight (8) initiatives aims to initiate a coordinated marketing campaign across the industry to promote aquaculture goods locally and to support the expansion of small-scale farmers and new entrants (DAFF, 2017b).

The DAFF publishes its Operation Phakisa Aquaculture Review reports on a yearly basis, with the first review published in 2015 reflecting on the achievements that took place in 2014–2015. The year two review was published in 2016, focusing on the progress and achievements in 2014–2016. Subsequently, the year three and four reviews were published in 2017 and 2018, respectively. Through these yearly review reports, it is evident that there are slow, but significant changes emerging in the aquaculture sector in terms of investments, production, job creation, transformation and GDP, amongst others.

The DFFE (2019b) reported on the progress of aquaculture key performance indicators, from the inception of Operation Phakisa in 2014 until 2019. It indicated that significant indicators were accomplished to develop the sector. Under initiative one (1), which looks at the selection and implementation of catalyst projects, it was reported that there are forty-five (45) projects, of which twenty-four (24) of these are Small-, Medium- and Micro-sized Enterprise (SMMEs). Table 2.3 highlight the actual achievements by the Operation Phakisa Catalyst Projects in 2018, against the projected performance.

Table 2.3: Progress on aquaculture key performance indicators in 2018

Performance Indicators	2018 Projections	2018 Actual Achievements
Investments (billion)	R1,90	R1,78
Production (tons)	13 347	3 548
Additional Jobs Direct Jobs	568	337
Transformation (SMMEs)	16	Only projection provided
GDP Contribution (billion)	R1,10	R0,58

Source: DFFE (2019)

The table above shows that there was significant achievement, especially in terms of investments in the sector, as approximately 93.7% of the projected additional investment was achieved during that period. While other indicators were still low, substantial developments have been made.

To contribute to the development of small-scale aquaculture and transformation, according to DFFE (2019a), the Department developed the Transformation Strategy and Small-Scale Policy through Operation Phakisa to support small-scale aquaculture and guarantee the effective transformation of the sector. This will help to foster the growth of small-scale aquaculture and transformation. Furthermore, small-scale feasibility studies were carried out and released in order to help new entrants to determine the minimal feasible scale for starting a small-scale aquaculture business. In light of the above literature review, it is evident that, through Operation Phakisa, some efforts were put into place to develop the small-scale aquaculture.

Halley (2019) conducted a study to assess the performance of Aquaculture Operation Phakisa Strategy implementation, focusing on the perceptions of key stakeholders, such as the implementers, and of the external stakeholders, such as aquaculture farmers who were registered with the programme. Using the Okumus (2003) Strategy Implementation Framework, Halley (2019) concluded that Operation Phakisa regarding aquaculture was implemented accordingly, and there were positive outcomes from the perspectives of both farmers and the implementers, although a lack of support functions negatively affected the implementation. He argued that, when an organisation's structures, culture and leadership are properly in place, a strategy implementation would be more successful. Furthermore, the research

demonstrated that comprehensive support functions could facilitate efficient communication, delineate roles and duties, and allocate resources to the implementation of the strategy (Halley, 2019).

Through a review of documents related to Operation Phakisa, such as the Operation Phakisa Lab Report and the Yearly Review reports, it is evident that the initiative was developed in order to fast-track the development of the sector as a whole, and was not tailor-made for only small-scale aquaculture development. The beneficiaries that are listed as catalyst projects are mostly commercial farms, although there are efforts in place to develop small-scale aquaculture, by which to transform the sector.

2.4.5 Aquaculture Technology Demonstration Centre

Aquaculture is said to be technical and difficult to enter into due to the specialised skills required for a successful operation (AgriSETA, 2021). AgriSETA (2021) further indicate that, since the sector is new in the country and there is limited institutional knowledge, there are few commercial farms that are sufficiently advanced in terms of relevant technology and technical know-how, while there is also a dearth of knowledge on the management and prosperity of small-scale aquaculture.

Rouhani and Britz (2004) found that rural aquaculture projects mainly failed, not due to lack of available land, water and infrastructure, but rather because they were not provided with ongoing technical support. The study revealed that rural aquaculture projects had received inadequate training, which was identified as one of the major weaknesses. The study conducted by the AgriSETA (2021) agreed that, with regard to small-scale farmers, they require Adult Education and Training (AET) in addition to training in technical skills (breeding, nutrition, and water quality) and management skills (managing an aquaculture farm and supervisory skills), which are all required for aquaculture operation. The study further emphasised the point that AET and aquaculture training interventions are needed to have a successful impact on small-scale farmers, and could only be fruitful if supported by knowledgeable extension services officers. Rouhani and Britz (2004) also indicated that training by itself is not adequate for the development of an aquaculture farm, and that ongoing technical support is required for an aquaculture operation to be successful (Rouhani and Britz, 2004).

Running an aquaculture farm is challenging, and expanding up to a commercial scale will require managers with knowledge, abilities and experience relating to aqua farms, processing and packaging, management, and system development, as well as advice from aqua biologists (AgriSETA, 2021). Workers need to be reoriented toward aquaculture farming due to its innovative and technical nature. Despite being underfunded, AgriSETA (2021) stated that extension officers serve as the main point of contact for freshwater farmers. They do not always give farmers the right advice, which might lead to complications. As a result of this, as well as not learning the fundamentals, the farmers are at risk of becoming caught in a cycle of low productivity.

A lack of aquaculture skills and extension services was also identified as a challenge hindering the growth and development in aquaculture (DAFF, 2013a; Operation Phakisa, 2014). The DAFF encountered difficulties in a number of areas when trying to expedite the development of a favourable environment for aquaculture (Parliamentary Monitoring Group, 2014). One of the challenges identified was a lack of capacity, specifically in the area of veterinary aquatic health specialists and aquaculture research and development. To address this, the Aquaculture Research and Technology Demonstration Centres had to be established in order to maintain coherence and focus.

The China-South Africa Agriculture Technology Demonstration Centre (ATDC) is the Chinese government's initial agriculture sector support initiative for South Africa (Van Niekerk and Moloi, 2018). The Chinese government contributed to the centre in an effort to support the development of aquaculture in South Africa and, as part of this initiative, offer farmers and fisheries agricultural extension services (Van Niekerk & Moloi, 2018). According to a research paper by Jiang *et al*. (2016), the ATDC is one of the first 14 ATDCs in Africa to be founded by the Chinese government, and it was created with the following objectives:

- to support China's foreign policy and foster mutual ties with the receiving nations;
- to assist in raising the production of grain, advancing technology in agriculture, and improving the food supply in the benefiting nations;
- to offer Chinese businesses a stage for growth in Africa and to further China's "Agricultural Going Out" policy; and
- to transform the ATDC into a hub for research and experimentation in agrotechnology, as well as for extension and demonstration, human resource training, and exhibitions.

The Centre, which is based at the Gariep Dam in the Free State Province, was completed in 2011, and in 2014, the ATDC formally entered into a Technical Cooperation Stage (Jiang *et al.,* 2016). The Chinese government, state-owned enterprises and private companies have played a role in terms of implementation, running the Centre, providing access to aquaculture experts, and offering technical support to the Centre (Jiang *et al.,* 2016). Two major actors were involved from South Africa's side: DAFF and the Free State Department of Agriculture and Rural Development (FSDARD). These actors supported the centre during the Technical Cooperation Stage and are anticipated to take over autonomously after that stage ends (Jiang *et al*., 2016).

The primary focus of the centre is placed on freshwater aquaculture training, demonstration, and research. Furthermore, according to Van Niekerk and Moloi (2018), the centre's fish breeding programme strives to provide advisory and extension services to farmers and fishermen. In addition, the centre supports the creation of high-quality fish stocks, resolving issues with breeding, and addressing deficiencies in fish output. Therefore, the centre responds to the shortage of aquaculture

skills and advisory services, which have been identified as comprising one of the key challenges hampering the development of small-scale aquaculture farmers.

Jiang *et al*. (2016) ascertain that government officials, technicians, and extension personnel, as well as smallholder farmers, were the three qualifications used by FSDARD to choose the trainees. In 2014, nine training sessions were organised, during the first year of the Technical Cooperation Stage. Of the 165 trainees who attended the courses, 100 were smallholder farmers employed by government-funded aquaculture farms in the Free State. Prior to the training for the farmers, around sixty-five extension officers and technicians from several municipal districts in the Free State underwent training. The skilled technicians and extension officers subsequently contributed significantly by assisting the Chinese experts with the extension of technology. Furthermore, the centre collaborated with the University of the Free State to create a programme that aimed to offer training courses to college students (Jiang *et al.,* 2016).

Additional activities offered by the centre included training programmes that blended classroom instruction with fieldwork. Regarding the smallholder farmers, the Chinese experts paid site visits to the fish farms to provide technical advice, such as modifying the feeding schedule and pond water temperature, or, in the case of government-funded farms, supporting smallholder requests for better technology to the local government (Jiang *et al.,* 2016).

However, Jiang *et al.* (2016) also reported that a few issues were experienced with the training development. One of these difficulties was that the farmers lacked access to the technologies utilised in the centre. As a result, the methods could not be used on their own aquaculture facilities. The inability of the Chinese aquaculture specialists to communicate effectively with the local trainees presented another difficulty. Furthermore, it was difficult for the specialists to convey the nuances of fish farming. This was a difficulty, particularly when the student had no prior experience or comprehensive understanding of fish husbandry.

The centre is currently operated by the FSDARD in collaboration and support from the DFFE (Van Niekerk and Moloi, 2018). It is evident that the centre was developed in response to address the lack of skills in aquaculture and extension services, especially for small-scale farmers. However, the small-scale farms are more evenly distributed amongst the provinces (Britz *et al.,* 2009) and so the location of the centre might pose a challenge, as small-scale farmers are distributed at distances, around the country.

2.5 Aquaculture public support programmes implemented in other countries

This study has also focused on government support programmes in developing countries with successful small-scale aquaculture. Literature has shown that China is the world's largest contributor towards global aquaculture production, and that Egypt is the largest contributor towards Africa's

aquaculture production. The literature further revealed that the aquaculture in both these countries consists mainly of small-scale aquaculture, while China over the years has been successfully able to graduate small-scale aquaculture into commercial aquaculture, with extensive support from government. The sub-sections below discuss in detail the literature, based on the public support programmes implemented in these two countries.

2.5.1 China

Hu *et al.* (2021) agreed with the authors mentioned above in this study who have reported that China has succeeded in reforming fisheries from captured fisheries to farmed fisheries. Hu *et al*. (2021) said that in 1950, the total output of aquaculture accounted for only 8.6% of the total fisheries products. Over the years, this changed, and in 1988, the aquaculture total production achieved 50.2% of total fisheries production, and managed to exceed that of captured fisheries, which accounted for less than 50%. Subsequently, in 1993, aquaculture became the primary production technique used in China to produce fish products, which has continued to increase rapidly most recently, with the total production of aquaculture accounting for 78.5% of total fisheries production (Hu *et al.,* 2021). Figure 2.3. below shows the performance of aquaculture in China from 1950 to 2019. From this, it is clear that China not only managed to build the industry, but it also further increased total production and maintained strong growth momentum. This sub-section will focus on the factors and government involvement that assisted in the growth and development of aquaculture in China to where it is currently.

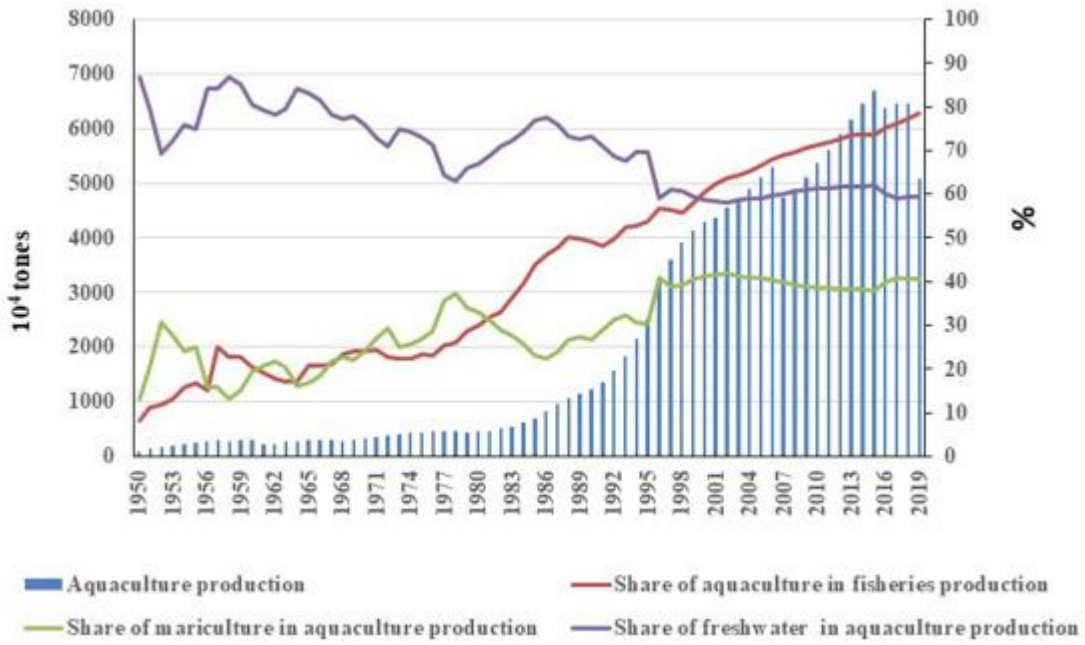


Figure 2.3: Chinese aquaculture development

Source: FAO (2003)

China is now the world's top producer of fish in aquaculture. According to Hishamunda and Subasinghe (2003), the country's ability to become the top producer is largely attributable to proactive government policies on fisheries and aquaculture, which are both competent and equitable, despite the country's size and population. According to FAO (2003), there are two policy regimes whereby the aquaculture industry in China developed significantly. These are the open-market economic system that took effect in 1978, and the egalitarian model that was implemented from 1949 to 1978. A summary of the many regimes that in some way aided in the development of aquaculture may be found in Table 2.4.

Table 2.4: Four stages of Chinese aquaculture development

Four stages of Chinese aquaculture development since 1949
Based on the various policies implemented by the government, the growth of aquaculture since the formation of the People's Republic of China in 1949 can be categorised into four stages: **(1) Recovery Period** **(from 1949-1957)** The new People's Republic reduced obstacles for farmers during this time by reorganising, mobilising, and restructuring the nation's production forces. The amount of fish produced rose annually, as additional land was made available for aquaculture. The government spent 1.25 billion RMB at this time to upgrade aquaculture facilities and infrastructure. Freshwater aquaculture thus advanced more quickly than marine cultivation did. **(2) Slowdown Period (1958-1965)** There was a relatively modest development in aquaculture between 1958 and 1965. Aquaculture's cultivated area shrank, as some ponds were filled-in for grain production. Furthermore, around this time, technology for artificially spawning was developed. This laid the groundwork for the swift growth of freshwater aquaculture. **(3) Stagnant Period (1966-1976)** The 'Culture Revolution' severely damaged the well-established framework for aquaculture development and fishery management. **(4) Rapid Development Period** **(1978 till now)** From 1978 going forward, the Chinese government accorded great importance to the fishing industry, particularly aquaculture, as a general policy and strategy to revitalise its flagging economy. The administration began implementing free market policies under the economic reform programmes, piecemeal starting in 1979. As a result, aquaculture grew not only in terms of space but also in terms of species farmed, which went from 20 to over 80. During this time, freshwater and marine aquaculture both experienced fast development.

Source: Hishamunda and Subasinghe (2003), Aquaculture development in China: The role of public sector policies.

For the purpose of this study, the focus was to assess the following government interventions executed by the Chinese administration to grow aquaculture for its nation, the aquaculture policies, the extension services, and the funding assistance towards aquaculture.

2.5.1.1 Legal and regulatory framework for the development of the sector

According to the FAO, China's aquaculture industry is overseen and controlled by the Fisheries Law of 1986, which was modified in 2000. The Ministry of Agriculture, which is the primary managerial agency overseeing the aquaculture and fisheries sectors in China, is home to the Bureau of Fisheries, which is in charge of aquaculture. The Bureau of Fisheries is responsible for developing strategies, policies, and programmes for the growth of fisheries; enforcing and monitoring fisheries laws; regulating bilateral and international agreements; administering fisheries to ensure the appropriate use of aquatic resources and protection of the fisheries environment; assisting with education and scientific investigations; and overseeing the fisheries processing sector. The provincial, independent regions, municipalities and counties fisheries departments in China have similar responsibilities as the Bureau of Fisheries has in their particular geographical locations.

In China, licences to utilise state-owned water sources and collectively-owned units for farming are granted by the government at or above the county level, in harmony with the Fisheries Law. The State designates mudflats, intertidal zones, and water surface regions that are used for aquaculture in its plans for their usage. If an organisation or individual wants to utilise those sites, an aquaculture permit is required and they must apply for it with relevant administration. Table 2.5 discusses these laws.

Table 2.5: Laws governing aquaculture in China

Area of responsibility/control on Aquaculture	Ministry	Competency/ Functions
Access to land	Ministry of Land and Natural Resources	Oversees the Land Administration Law, which addresses landownership, use, and planning matters. Additionally, the law grants farmers 30-year contracts, officially granting each cultivator ownership over a certain plot of land.
Access to water	Ministry of Water Resources	It oversees the administration of the Water Law (1988, revised in 2002), which governs the allocation, development, use, preservation, and safeguarding of water resources.
	State Oceanic Administration (SOA)	It is the agency of Ministry of Land and Natural Resources and is responsible for enforcing the 2002 Sea Area Use Management Law. Growing disputes over numerous uses in maritime areas led to the adoption of this law. The Law also establishes Marine Functional Zonation Schemes, which list the usages of a certain marine region, based on their priority. Planning for sectoral development (including aquaculture), urban development, port operations, and coastal land.
EIA	The State Environmental Protection Administration (SEPA)	Various environmental laws contain provisions pertaining to EIA requirements; however, none of them specifically mentions aquaculture. The Environmental Protection Law (1989) is administered by the SEPA, which also takes the lead in general management of environmental matters. As per the legislation, the departments of environmental protection administration that are competent and operate at a level higher than the county level are required to inspect and conduct evaluations of the environmental conditions in the areas they are responsible for.
Water and wastewater	Ministry of Water Resources	Various environmental laws have provisions for wastewater discharge and water quality; however, none of these laws particularly mentions aquaculture. National requirements for the quality of the water environment and the discharge of water pollutants are established by the Law on the Prevention and Control of Water Pollution. For products not covered by national standards, local standards may be set by the provinces, regions, and municipalities.
Fish movement	Ministry of Agriculture	The goal of the 1991 Entry and Exit of Animal and Plant Quarantine Law is to stop the importation or exportation of contagious or parasitic diseases. As a result, upon arrival or departure, animals and animal products, as well as other items, are subject to quarantine inspection. Quarantine certificates from the exporting countries' quarantine departments must be sent with them. Furthermore, the Law on the Protection of Wildlife (1988) seeks to preserve and safeguard wildlife species that are endangered or critically endangered.

Source: Hishamunda and Subasinghe (2003)

2.5.1.2 Policies and Programmes

Hishamunda and Subasinghe (2003) noted that the national policies aimed at achieving food self-sufficiency and economic growth propelled the expansion of China's aquaculture industry. Hishamunda and Subasinghe (2003) further indicated that aquaculture development in China is practically an entire outcome of government policies, although some non-policy aspects played a slight role. The Aquaculture Industry Growth Pattern Transformation Action Plan was developed in 2006 by the Ministry of Agriculture. China's aquaculture business has developed significantly as a result of these regulations and policies. Additionally, the State has developed strategies and policies for rural development as well as for the growth of agriculture, aquaculture, and capture fisheries in order to create a rural economy (Zhiwen, 1999). According to Hishamunda and Subasinghe (2003) several specific fisheries policies were developed to promote the expansion of aquaculture, which are discussed below.

a) *Directive Notice on the Approval and Implementation of the Instruction of the Ministry of Agriculture to Further Expedite the Development of the Fishery Sector*

This Notice necessitated the improvement and liberalisation of the market to reinforce the growth of aquaculture and a fundamental modification of the arrangements of the fishery sector and procedures to endorse the development of the economy. Furthermore, it ordered that the species combination and production structures be made suitable to the market environment, and that advance technology practices be prioritised to expand the performance of the sector.

b) *The Instruction of Broaden Policies to Accelerating Fisheries Development*

This document stressed that the growth of aquaculture ought to be seen as strategically significant, particularly in rural areas, and that it must be prioritised and encouraged. For the first time, national policy for fisheries development explicitly prioritised aquaculture. The document emphasised the concurrent development of aquaculture, capture fisheries, and processing. It also encouraged participation from state-run enterprises, collectives, and individual farmers. This policy further endorsed the expansion of the contract responsibility system, which played a significant role in China's economic reforms.

c) *The Suggestion on Further Speeding Up Fisheries Development*

This document instructed the policy of fisheries development "to fast-track aquaculture development, to protect and rationally utilise offshore resources, actively enlarge distant fishery, pay special attention to processing and circulation, and strengthen legal management." The policy placed emphasis on the advancement of aquaculture, boosting output with new technology, introducing new species, controlling cultural species, and aggressively cultivating fish species that are high-value, aligned to regional environment and market requirements.

These policies showed the commitment of the government to grow the sector. It is noted that these policies promoted market access, new technologies and high-value species, and the production of new

species was incentivised. Resources such as land and water were made available and prioritised for aquaculture use.

2.5.1.3 Aquaculture extension system in China

Jiang *et al.* (2018) have stated that, in order to foster the growth of aquaculture, the Chinese administration has worked hard to advance technical training through using enhanced extension programmes. According to the FAO, the primary goal of aquaculture extension is to support and motivate aquaculture farmers to implement better farming practices in order to boost fish output and revenue creation. According to Fletcher (2020), the Chinese aquaculture extension system has been the primary driver of the growth of the aquaculture sector in the nation for the previous 40 years. A significant element in the growth of aquaculture in the country is the extensive and high-calibre extension services offered to farmers. The government has been a major supporter of extension services from the beginning (Hishamunda and Subasinghe, 2003). Wang *et al*. (2020) showed that the development of aquaculture extension took some time, and that the five-level system was created after years of various modifications.

The formation of the five-level aquaculture extension was instituted in 1978 as a result of a series of policies and administrative notices that were made to encourage the development of a comprehensive, national aquaculture extension system. The five-level aquaculture extension model consists of demonstration centres, technical extension programmes, as well as technical consulting. It also includes social organisations, aquatic initiatives, research institutions and universities, which are also equally significant (Wang *et al.,* 2020). This system was described as a comprehensive aquaculture system and has undergone four progressive phases over the past 70 years.

The Fishery Administration of MARA oversees Chinese state-owned extension groups, which are divided into national, provincial, municipal, and county domains, as well as town level. Each category has specific responsibilities. For both national and provincial extension groups, the responsibilities include the following:

a) offering a national extension plan and direction for creating the entire system of aquaculture extension;
b) overseeing the introduction, evaluation, and display of important aquaculture technology;
c) limiting the spread of diseases and offering technical assistance and disaster forecasting;
d) setting up technical instruction and skill-building programmes for farmers and aquaculture extension workers; and
e) distributing aquaculture extension resources and encouraging international cooperation.

The city-level, town-level and county-level extension institutions offer products, such as administrative services, marketing services and technical services, directly to aquaculture farms.

The research institutions involved in aquaculture focus on conducting government's research assignment, creating and promoting new aquaculture production technologies and recommending activities for extension to other departments. Universities also form part of the extension system in China. These universities pay attention to educating extension officials, specialising in technology, developing new farming technologies, new breeding species, and rendering extension advisory services to the government.

The Chinese Fisheries Association and Chinese Aquaculture Association are two social organisations that are a part of the extension system. These organisations consist of government officials, industry personnel, and aquatic experts. The role of these organisations is to inform and advise aquaculture farmers on technologies, species, and policies and regulations. In addition to this, the organisations offer scientific advice to farmers to support them with making decisions on aspects that affect farming profitability, such as species, breeding approaches and stocking density.

This extension structure is said to have had a positive effect on the growth of aquaculture in China. Under the extension system, aquaculture became a major global supplier of aquatic products, as well as a significant component of the country's food supply. Additionally, it has improved information and training accessibility, as well as production capacity. Wang et al. (2020) emphasised that, since 2006, China has formed a "comprehensive aquaculture extension system where advanced technologies are successfully transferred to industry participants. The result is that Chinese aquaculture is better promoted and producers are more efficient, which has increased their incomes."

2.5.1.4 Educational institutions

In addition to extension services, China has a large number of educational institutions that offer aquaculture education. Specialised, elementary, secondary, higher, adult education and vocational education at various levels are all included in China's fishery education system. The Department of Freshwater Fisheries (mostly freshwater aquaculture) and the Department of Mariculture are located in the five fisheries universities/colleges. These institutions provide four years of instruction. For the purpose of the fieldwork, there are eight freshwater and marine culture farms, totalling more than 80 hectares of water. In addition, the other seventeen universities specialise on fisheries, including aquaculture. A majority of these specialise in aquaculture, and have become the technical backbone of the frontline technical services of rural aquaculture.

The students are taught basic theory courses, followed by practical courses with field work. Students have to fulfil the production targets set in field work, which are viewed as a measure of the students' performance and graduation.

2.5.1.5 Financial support

a) Government loans

Hishamunda and Subasinghe (2003) have indicated that the Chinese government has promoted joint ventures or partnerships between the Central and Local Governments in order to grow aquaculture. It also established a tax system, with the intention of sharing the tax load on investments between the foreign and domestic private investors and the Local and Central Governments. According to Zhiwen (1999), the Chinese government prioritised credit facilities for farmers to support the aquaculture farmers to expand their production and improve their competitiveness through improving their credit facilities.

b) Government subsidies

Government-granted subsidies have provided support for production. The subsidies were provided through the Agriculture Supporting Fund to help aquaculture farmers to build fish ponds. The fund provided funding according to the size of the fish pond; 500 yuan were granted as an operating fund by the state for each 1/15-hectare fish pond; the remaining required funds were raised by the farmers. This indicates that this subsidy was a cost-sharing fund, which required a certain portion of the required capital to be funded by the farmer.

Government subsidies have had a significant impact, and increased the number of farms, as well as production. According to Zhiwen (1999), the government provided 36.9 million yuan in support capital between 1980 and 1985, and the fish ponds that were constructed with that money covered 16 200 hectares. In 1982, the government set aside money for the construction of commercial fish production bases, at a rate of 1,500 yuan per hectare. Furthermore, up to 150 yuan per hectare was subsidised for intensive production on small natural waters. Through subsidies, the State also encouraged the farming of particular species. For instance, to encourage the farming of prawns. The State first provided 3,000 yuan to create a pond for shrimp culture of a single hectare. The counties, municipalities, and provinces also participated in these subsidy arrangements.

c) Bank credit

Another form of financial support available is credit obtained through the banks. As the number of private farms and other aquaculture operations increased in the economy, they opted to obtain loans from banks. Zhiwen (1999) states that the Agricultural Bank of China and the Agricultural Financing Cooperation have been the primary sources of financing in recent years. Additionally, the government created a credit policy, based on the national strategy for agricultural development. The challenge currently faced by small-scale aquaculture operations in China is that they struggle to gain credit from banks due to the excessive risks experienced in aquaculture. This has resulted in some fish farmers borrowing usurious loans from illegal private credit providers, which carry interest rates possibly as high as 20–30 percent.

2.5.2 Egypt

According to Rothuis and Van Duijn (2013), Egypt is a prominent player in the aquaculture sector, worldwide. Over the last seven years, Egyptian aquaculture has grown remarkably (Wally and Akingbe, 2022). As a result of this rise, Egypt is now one of Africa's top producers of aquaculture, accounting for almost 64% of all aquaculture production in 2011, reaching number six in global aquaculture output, and number three in tilapia output, worldwide. Egypt's economy and food security continue to benefit greatly from aquaculture, and it is predicted that rising fish demand brought on by population growth and economic expansion will call for a maintainable surge in production of fish through using advanced technologies, premium feedstuffs, water-saving innovations, and ethical fish farming methods (Wally and Akingbe, 2022). Currently, fish farming provides over 65% of the total fish output in the country and it is the major individual source of fish supply, with over 99% of this production coming from privately held farms (FAO, 2003). Aquaculture is regarded as the only viable way to boost Egypt's fish production.

The FAO (2003) went on to say that Egypt's modern aquaculture industry began to flourish and expand two decades ago, and that this led to a notable and quick expansion that sharply increased productivity. Egypt produced a total of 705 490 tons of aquaculture in 2009, valued at USD 1 354.646 million on the international market (FAO, 2003). The strategy developed by the Ministry of Agriculture and Land Reclamation called for increasing the nation's overall fish output to 1.5 million tons in 2017, with 1 million tonnes coming from aquaculture. Aquaculture has expanded at rates higher than those specified in the strategy (FAO, 2003).

Further growth was noted in 2016, when the total production reached 1.37 million metric tons, and it increased by 18.2 percent to 1.62 million metric tons in 2020 (Wally & Akingbe, 2022). Wally and Akingbe (2022), in their additional estimates, noted that the global fish production in 2021 was expected to be 2.2 MMT, of which 1.7 MMT came from aquaculture. It is observed that the major increase in the usage of new technology, water circulation systems, usage of extruded feedstuff and enhanced farm management methods, were primarily responsible for the increase in aquaculture productivity. The industry became increasingly sophisticated and varied as a result of the quick growth of auxiliary businesses, including domestic feed mills and hatcheries (Soliman & Yacout, 2016).

According to FAO (2003), Egypt presently cultivates two types of crustaceans and fourteen different species of finfish. Six of the species have been introduced, while ten are native. The aquaculture products are sold and consumed locally because Egypt is not yet self-sustaining in fish, meaning they do not produce enough to feed the country, and therefore Egypt imports fish to substitute and to ensure that per capita consumption is met (FAO, 2003).

2.5.2.1 Legal and regulatory framework for the development of the sector

The primary piece of legislation pertaining to fisheries in Egypt is Law No. 124/1983 on fishing, aquatic life, and the regulation of fish farms. It is overseen by the Ministry of Agriculture's General Authority for

Fisheries Resources Development (GAFRD), and the legislation includes certain criteria related to aquaculture (FAO, 2003). Table 2.6 below shows the different government departments involved in aquaculture, together with a summary of their competencies.

Table 2.6: Laws governing aquaculture in Egypt

Area of responsibility/control over Aquaculture	Ministry	Competency
Aquaculture Regulation and Policy Development	Ministry of Agriculture and Land Reclamation (MoALR)	Law 53/1966 and Resolution 162 of 1996 constitute the Ministry's primary legislative frameworks. The Ministry is in charge of creating general policies for land reclamation, agriculture (including aquaculture), and the growth of rural economies. Research and study are also required in order to advance agriculture.
Authorisation System	MoALR	A licence granted by the MoALR, following approval from the Ministry of Water Resources and Irrigation (MoWRI), is required in order to operate a fish farm. The licence must specify the amount of water that can be used, where it comes from, how big the inlet is, how drainage is done, and the terms of the permission granted.
Water Use and Wastewater	MoWRI	The Ministry' aims to create irrigation systems that maximise water utilisation, while maintaining water quality and quantity. Fish farms must receive approval from the Ministry, through its inspection bureaus, in order to be granted a licence. The Authority for Shore Protection must grant approval to marine fish farms.
Leasing of Aquaculture Sites	GAFRD	The MoALR controls how agricultural lands are used centrally. The authority of GAFRD to lease any areas within 200 metres of the shore for fishing and aquaculture activity is outlined in Presidential Decree No. 465/1983. Only land designated for aquaculture may be leased for the purpose of aquaculture (via GAFRD). Through a public tender, sites are leased to investors for a term of five years; the lease value is established by taking into account the location, infrastructure, availability of services, and production capacity.
EIA	Egyptian Environment Affairs Agency (EEAA)	The Ministry's Egyptian Environmental Affairs Agency (EEAA) is in charge of putting laws into effect. According to the Primary Environmental Law, Law No. 4/1994, as revised by Law No. 9/2009, fish farmers must receive the Agency's permission before submitting an EIA study in order to obtain a licence.
Fish Movement	GAFRD	The organisation in charge of all fish production planning and control operations is GAFRD, a division of the MoALR. Created by Law No. 190/1983 with the intention of using fish resources to support the growth of the country's economy by implementing projects for both parallel and upright extension that fits within the parameters of the state plan and general state policy.

Source: (FAO, 2003)

Goulding and Kamel (2013) have indicated that, in addition to above ministries, other ministries that have oversight over aquaculture, and whose consent might be needed, comprise the Authority for Shore Protection, the Ministry of Tourism, the Ministry of Archaeology, and the Border Guard (affiliated with the Ministry of Defence).

2.5.2.2 Policy framework for aquaculture in Egypt

According to Plumber (2019), Egyptian aquaculture began growing around 1984, and in 1997, industry growth accelerated substantially. According to Wally and Akingbe (2022), the country has a fisheries and aquaculture development plan in place to increase fish output to three million metric tons by the year 2025, where, in order to achieve this, the government will:

- develop inland fisheries in the identified suitable lakes;
- promote the growth of aquaculture via multinational initiatives;
- develop shrimp farming and the establishment of hatcheries for the production of fish seed, with a focus on marine fish seed; and
- develop integrated fish farming, particularly in light of the growing area of reclaimed land.

a) Fisheries and aquaculture policy

In 2015, the GAFRD designed a strategy for the growth of the aquaculture and fisheries industries through to 2017 (Goulding & Kamel, 2013). By using ecologically friendly systems, the policy sought to raise Egypt's fish resource production and returns. In order to maintain per capita fish output in line with population growth, it was also necessary to achieve an annual output of 1.5 million tons, with a per capita, per year amount of 16.5 kg of local fish by 2017. Finally, in order to assist the growth of marine aquaculture, fish products would be enhanced to meet international standards or needs. In addition to promoting investment in marine aquaculture, GAFRD designed a two-sided approach to boost the efficiency of freshwater aquaculture operations. The scarcity of freshwater resources at the time was the reason for this, and as a result, the country policies now support marine aquaculture (Dighiesh, 2014).

b) Strategic Framework for Economic and Social Development Plan until 2022

In an effort to address the concerns of Egyptian citizens for social justice and a more inclusive system by 2022, Egypt created the Strategic Framework for Economic and Social Development Plan in 2012. The strategy states that doubling the country's revenue and providing increased numbers of jobs would be its ultimate goals. According to Goulding and Kamel (2013), the strategy stresses the value of the fishing and agriculture industries to the economy, since they make substantial contributions to the GDP and labour force participation. The framework aims to boost exports by boosting value added, increasing post-harvest processing activities, and fostering synergy between the industrial services and agricultural sectors by encouraging innovation in marketing and distribution.

c) Water Resource Management Policy

According to Goulding and Kamel (2013), Egypt is mostly reliant on the Nile River for water needs as it is a water-scarce nation. For this reason, the accessibility to productive land and the restricted water sources serve as the primary constraints on State policy for agriculture, including aquaculture. To address the challenges of meeting the water requirements of diverse industries in the State, the MoWRI in 1975 adopted water resource management policies. The goals of the policies prioritise the social and economic facets of development. From an economic perspective, the strategy seeks to maximise the usage of water sources by different economic industries, such as agriculture, including fish farms, and drinking water, in order to endorse increased productivity. Although the policy acknowledges the need for supporting aquaculture, it did not significantly alter the MoWRI's stance regarding aquaculture's entitlement to the first use of water. Aquaculture is still prohibited in canals that carry water from the Nile and supply water for irrigation by agriculture and a source of drinking water.

2.5.2.3 Extension services

There is inadequate information regarding aquaculture extension services in Egypt. However, Rothuis and Van Duijn (2013) indicates that Egypt has a National Aquaculture 2030 Strategy in place, and its main elements include developing freshwater aquaculture and marine aquaculture, and the establishment of pilot and demonstration farms for training and extension services. However, according to Rothuis and Van Duijn (2013), under the then-current political environment, it was not clear as to whether there were capacity and resources available to implement the strategy. They further indicated that extension services were not functioning, that no specific budget was available for aquaculture, and that the connections between government, research institutions and the aquaculture industry were weak. Furthermore, the licensing of new operations proved to be slow, owing to multiple ministries being involved in the process of licencing.

The FAO (2013), through the country's NASO, has indicated that there are several Government research organisations and a university that specialise in fisheries research and education. The research conducted generally focuses more attention on practical requirements intended at improving production efficiency. Rothuis and Van Duijn (2013) emphasise that aquaculture, at the time of their study, was a low priority of government, that there was a weak professional organisation, as well as a weak connection between research and industry. However, according to NASO, specific research topics are mainly chosen after discussions among research organisations, the Egyptian Aquaculture Society, GAFRD, and the producers. Farmers and scientists debate production issues at frequent events, such as conferences, workshops, and meetings. Moreover, government-run institutes and private businesses sometimes involve farmers in research projects. Research findings are typically published in scientific journals for wider distribution, although condensed articles can also be issued in other publications and magazines and made available to farmers, specialists, and technicians by local aquaculture associations. Through the publication of basic extension papers, the GAFRD extension and training directorates are responsible for disseminating information to farmers with lower levels of

knowledge. Furthermore, GAFRD plans and provides free aquaculture training programmes (FAO, 2003).

According to Goulding and Kamel (2013), the Egyptian Fish Producers and Exporters Association (EFPEA) and Aquatic Resources Cooperative Union (UAC) are two significant organisations that advocate on behalf fish producers in Egypt. Although EFPEA and UAC share the same goal of serving as advocacy groups for their members, they are not equipped with the necessary financial, managerial, or technical resources to create a planned strategy for the growth of the future initiatives of their respective organisations. For this reason, there is insufficient representation of farmers in Egypt's policy discourse owing to the lack of robust and representative organisations and associated procedures. Consequently, new rules, regulations and policies do not sufficiently consider the unique demands of fish farmers, leading to farmers being generally excluded from relevant conversations as a result of restricted participation, inadequate capacities, and poor coordination.

2.5.2.4 Funding support

Small and Medium Enterprises (SMEs) constitute more than 90% of Egypt's private businesses, and they share similar challenge as in developing nations, where there is limited access to finance. Rothuis and Van Duijn (2013) have reported that the percentage of bank loans to the agricultural industry, which encompasses aquaculture, constituted a mere 2.5% of all outstanding loans, at the time of their report. This could be attributed to the fact that the commercial banks and state-owned institutions are hesitant to fund aquaculture, owing to the reluctancy of the industry and its unwillingness to properly assess the risks associated with such projects. Furthermore, the perceived risk attached to aquaculture is a main contributor to the lack of access to funding. Rothuis and Van Duijn (2013) further indicated that loans also require collateral security to be provided and that loans are only approved after the authentication of the client's land ownership; while most of the aquaculture SMEs in Egypt do not own land, but lease it. Soliman and Yacout (2016) noted that farmers in Egypt generally lease land from the government, and although the rent is usually low, the challenge is that the lease periods are short, at only 3–5 years duration.

However, Obwanga *et al*. (2018) have indicated that tax breaks/tax holidays, incentives, and waivers on imported cages are granted by government as incentives that have stimulated investments in Egyptian aquaculture. Nevertheless, large-scale farmers have benefited more, to the detriment of the small-scale farmers. Furthermore, according to Obwanga *et al*. (2018), Egypt has encouraged small-scale farmers to transition to commercial operations, which has resulted in private investments being made in the aquaculture industry, particularly in the fingerling and feed industry.

2.6 Methodological issues for assessing appropriateness and sufficiency

A literature review reveals that studies focusing on assessing or measuring the appropriateness of an intervention are common in the Humanitarian Assistance field, as well as in the Medical field. According

to Abdelmagid *et al*. (2019), methods that are better organised and systematic for determining the appropriateness of humanitarian responses are required for accountability purposes, as they play a vital role in defining the effectiveness and attainment of results and value for money. According to Abdelmagid *et al.* (2019), 'appropriateness' in the context of humanitarian assistance relates to how well-suited a number of factors are to the larger crisis context; these include the goals of a response, the interventions chosen, the size or geographic scope of the response, the beneficiaries it is intended to assist, and the acceptability of the interventions in terms of culture.

The efficiency, effectiveness, impact, sustainability, and relevance of humanitarian assistance programmes are among the standard evaluation criteria used by the OECD/DAC. According to the OECD (1999), determining relevance means determining whether the project/programme aligns with donor policy as well as with local needs and objectives. However, the evaluation criteria of 'relevance' have been replaced with the criteria of 'appropriateness', which focuses on the requirement to design humanitarian interventions in line with the local needs, improving accountability, ownership, and cost-effectiveness (Minear, 1994). The OECD (1999) further indicated that the two criteria complement rather than substitute one another. The OECD (1999) briefly defines 'relevance' as the level at which a given intervention's purpose and the strategy respond to beneficiaries and it answers the question of "is the intervention doing the right things?" (OECD, 1999, p.11). Furthermore, according to the OECD (1999), 'Relevance' refers to the general objective and the drive of a programme, while 'appropriateness' pays more attention to the inputs and activities (OECD, 1999).

Measures of appropriateness are applied in the medical field to assess the overuse and underuse of medicinal therapies. This came about as a result of a number of studies, suggesting that most health care is delivered inappropriately (Hicks, 1994). One common method to measure appropriateness in the medical field is the Rand approach. This approach created a systematic method to generate standards that might be used to measure the appropriateness of care intervention. The method further involves a selection of panellists or participants who then rate the appropriateness of the care intervention, based on the review of literature provided, on a nine-point scale (1 being 'extremely appropriate' and 9 'extremely not appropriate') Hick (1994). According to Hicks (1994), appropriateness is understood as an abstract concept, the evaluation of which invariably requires value assessments to be made. The evaluation of appropriateness relies much on the setting in which the care is provided and the verdict is made.

Further to this, Hicks (1994) concluded that appropriateness is seen as an abstract concept. This means that to conduct the study, it is necessary to operationalise the concept of appropriateness. The term operationalisation means turning abstract concepts into measurable observations (Bhandari, 2022). From both Abdelmagid *et al.* (2019) and OECD (1999), it is evident that determining an acceptable criterion that takes into account the needs of the impacted community is a necessary step in determining appropriateness. Therefore, in order to measure appropriateness, the study will focus on how the support programme addresses the small-scale aquaculture farmer's needs.

In terms of sufficiency, Jungell-Michelsson and Heikkurinen (2022) conducted a study to review and provide an analysis of the concept of sufficiency, focusing on micro- and macro-economics, consumers and producers as actors. Their study served to contribute to the developing field of sufficiency studies by providing a comprehensive understanding of the concept and its disciplinary origins. Moreover, the study aimed to elucidate the definition of ‘operationalising sufficiency’. Jungell-Michelsson and Heikkurinen (2022) used systematic literature to collect data from sufficiency scholars. Researchers such as Princen (2005), defined sufficiency to a certain degree, articulating the idea of sufficiency, oe what may be termed, ‘enough’. Jungell-Michelsson and Heikkurinen (2022) identified ‘enoughness’ as the normative starting point of the sufficiency field. In light of this literature reviewed, it is clear that, although sufficiency is used in different fields, it is a transdisciplinary concept of 'enoughness'. This research will assess the ‘enoughness’ of public support programmes to meet the needs of small-scale aquaculture to promote their growth. The Vocabulary Dictionary (2023) also shows that, although enough has to do with the amount of something, it is not quantifiable.

According to the results of the study by Jungell-Michelsson and Heikkurinen (2022), sufficiency is a complicated and multidimensional notion that affects both supply and demand, in addition to consumers and consumption. Consequently, it was determined that, because sufficiency is abstract, it might be challenging to operationalise, in the sense that producing organisations might need to select certain parts of the idea to emphasise, while consumers would inherently gravitate toward other components (Jungell-Michelsson and Heikkurinen, 2022). It is clear that, similar to appropriateness, sufficiency is an abstract concept that requires operationalisation to be measured. Furthermore, it can be said that the government, as both a service or product provider, could choose certain aspects for determining sufficiency, and that consumers, in this case farmers, might also choose other aspects to determine sufficiency. In order to operationalise sufficiency, this study will determine whether the available support programmes are sufficient to address the needs of small-scale aquaculture.

2.7 Summary

This chapter has provided a literature review on the status of aquaculture globally, on the continent of Africa, and in South Africa. It describes the different categories of aquaculture producers and their characteristics. It discusses the major challenges impacting small-scale aquaculture development, which comprise the lack of access to finance, regulatory barriers, lack of skills, and access to land, among other things. The chapters show how previous studies have measured the relevant appropriateness and sufficiency. It further explored various government support programmes and policies implemented in South Africa. It explains how China and Egypt have implemented various programmes backed by policies and have successfully developed small-scale aquaculture in their countries.

CHAPTER 3:
METHODS AND PROCEDURES

This chapter aims to explain the methods and procedures used to collect and analyse data and how each specific objective is addressed. It describes how the research was conducted so as to assess the sufficiency and appropriateness of public support for developing small-scale aquaculture in Gauteng. It provides a description of the research design, the methods and procedures used are then defined, and the rationale for why they are used and are appropriate for the study is described. Lastly, the chapter outlines and describes the statistical techniques used to determine the validity and reliability of methods utilised to collect and analyse data.

3.1 Research design

The research design refers to the complete research approach or plan utilised to combine the components of the study to be undertaken in a comprehensive and rational plan, thus, the research design guarantees the effective tackling of the research problem through the collection, analysis, and interpretation of data, together with a discussion of results (Kirshenblatt-Gimblett, 2006).

Hashim (2017) states that the pragmatic approach comprises the utilisation of methods that are best suited to the research problem. This is to allow a deeper understanding of the study problem to be achieved. The pragmatic approach is a mixed technique of research that gathers, analyses and combines both quantitative and qualitative research methods. Consequently, a pragmatic strategy approach was taken for the purposes of this study, utilising both quantitative and qualitative data (Denzin, 2010). This study used both primary and secondary data collection methods. Furthermore, it utilises both qualitative and quantitative data. A baseline assessment was conducted to determine the status quo of the aquaculture sector in the global and regional contexts and to narrow it down to the South African aquaculture sector. In order to determine what dynamics are present in the literature and what research has been done, a literature review was utilised in order to analyse various literature sources. The analysis of the literature was also essential for gaining an understanding of the research topic.

3.2 Study area

A study area is defined as being formed by geographic restrictions selected to describe the scope of research analysis. The study area can be defined when starting a research project to ensure that data and analyses are confined to a specified area (ArcGIS, 1999). In the case of this study, the research was conducted in South Africa, and served to examine small-scale aquaculture and the relevant government programmes in the country. Although the study focused on the public programmes

implemented on a national level, and not on a provincial level, the study area selected focused on small-scale aquaculture farmers based within the Gauteng Province.

This is because, as the literature has indicated, small-scale farmers are dispersed around South Africa, and a study of all the provinces would have required greater time and resources to conduct such wide research. The DFFE (2019) stated that a total number of 229 fish farms were reported to be operating in 2018, with 39 of the farms cultivating marine species and 190 farms cultivating freshwater species. Britz *et al*. (2009) and the DFFE (2019) reported that freshwater aquaculture is mostly cultivated on a small scale. The 190 farms consisted of 39 farms recorded in Gauteng and Western Cape, respectively, followed by Mpumalanga with 28 farms, Limpopo (24), North West (21), KwaZulu-Natal (18), the Eastern Cape (10), the Free State (8) and the Northern Cape (3) (DFFE, 2019).

As indicated by DFFE (2019), there were about 39 farms recorded in Gauteng. Using the Google search term “aquaculture farms in Gauteng Province” ascertained that 43 farms, as of January 2023, were operating in Gauteng. Slovin’s formula was a preferred method for selecting an ideal sample size, so as to ensure that respondents are representative of the small-scale aquaculture in Gauteng Province.

South Africa has different government support programmes that are provided at national, provincial and local levels. For example, the Eastern Cape, through the Eastern Cape Development Corporation (ECDC), has an initiative called Imvaba Cooperative Fund, which offers funding support to cooperatives within the Eastern Cape alone, thereby excluding farmers in other provinces. For the purpose of this study, focus was placed on government programmes available on a national level. The following programmes were assessed in detail:

- the Aquaculture Development and Enhancement Programme (ADEP); and
- the Aquaculture Technology Demonstration Centre (ATDC).

These two programmes were chosen for the purposes of this study because they were implemented to address the main challenges identified in the literature review, which were the lack of accessibility to finance and the lack of skills development.

3.3 Research population

In order to determine a sample for the current study, a population of small-scale aquaculture farmers located in Gauteng Province was selected. A complete group with a shared set of features is referred to as the research population, according to Lim and Ting (2012). There is a lack of information on the precise numbers of small-scale aquaculture farms currently operating in South Africa. However, the literature does reveal that there were 190 freshwater farms operating in 2018, of which 39 were based in Gauteng Province, mainly operating on a small scale. The study’s entire research population consisted of individual, small-scale aquaculture producers operating in Gauteng Province, South Africa.

The research identified small-scale farmers who share a common set of characteristics, as defined by the SA Development Bill (2018), as being farmers producing on a scale of fewer than 20 tons per annum and employing fewer than 10 employees. Because it can be difficult or hardly practical to gather data from each individual in the population, a sample selection was chosen through using purposive sampling.

3.4 Sample selection

Shona (2019) has defined sample selection as selecting a group of people who will genuinely take part in a study. Data from small-scale farmers engaged in primary operations and sharing comparable attributes, such as size and number of jobs, were selected and gathered through the use of purposeful sampling. The sample also included secondary or ancillary aquaculture operations. According to Dudovskiy (2016), purposive sampling methods are time-saving and cost-effective and can be used where a limited number of farms might serve as primary data sources. For this reason, this sampling method was the preferred method for this study.

A sample size formula was used to determine the size of a representative sample or the number of participants. Since much is unknown about the population, Slovin's formula was the preferred method the study. The following is Slovin's formula, which is used to determine an acceptable size of a sample from a population (Blaizot *et al.,* 2019), and the formula is as follows:

$$\boldsymbol{n = N / (1 + Ne2)}$$

where:

n = Number of samples;

N = Total population; and

e = Error tolerance (level).

As indicated, the literature reveals that 39 freshwater farms were operating in Gauteng in 2018, mainly operated on a small scale. Accordingly, 39 farms were used as the population for this study. According to Williams (2021), meaningful results can still be obtained with an acceptable margin of error of 4% to 8%. Moreover, it has been shown that lowering the sample size in situations with a small number of participants can be achieved by raising the error margin. For this study, the margin of error was selected as 6%, at a 90% confidence level. Thus, the sample size obtained employing Slovin's formula is as follows:

$$n = N / (1 + N\,e2)$$

$$= 39/ (1 + 39 * 0.06)$$

$$n = 33$$

The study selected a sampling framework of thirty-three (33) participants to attain the scope of the research study. The sample was selected, considering the small nature of the sector and that there is a limited number of farms, which might also contribute to difficulties in gathering information. Small sampling enabled the researcher to conduct an in-depth inquiry.

3.5 Data collection and analysis

3.5.1 Data collection

The section elaborates on how and what data was collected, and how it was analysed to address each specific objective.

To achieve and address specific objectives One, Two and Three of this study, primary data was collected using surveys and semi-structured interviews, conducted with small-scale aquaculture farmers in Gauteng and the three departments implementing the ADEP and ATDC programmes identified as the DTIC, FSDARD and DFFE. The University of Pretoria granted ethical approval to conduct the current research study in January 2023. A questionnaire for surveys was designed, consisting of structured, open-ended questions and a Likert scale. Semi-structured interviews were also conducted with the selected sample, where further clarity was required. Conducting interviews after literature review and the surveys are completed, assisted in building on the findings and closing the gaps found in the literature and the surveys.

Contact details for the small-scale producers were requested from government sources, and a search was conducted on the internet. The government database listed only 17 farmers, for whom only 11 farms had contact details. This led to Google search being done, using a word search for “aquaculture farms in Gauteng Province.” The search gave the results of 43 farms. Some of these farms also appeared on the Department’s database, which reduced the number of farms to 35. Of the 35, only 19 had working contact details, for both email and telephone. Furthermore, snowball sampling was conducted, where participants provided referrals to other small-scale aquaculture farmers who might participate in the study.

At first, phone calls were made to farmers with telephone numbers to request consent for their participation. Surveys were then emailed to participants, who were given two weeks to respond. Data collection took place from 4 March 2023, anticipating receiving completed questionnaires by 31 March 2023. However, owing to an unwillingness to participate in the study, the period to collect data was extended until 30 June 2023. Upon the submitting the completed questionnaires, participants were requested for an interview in cases where certain responses were unclear.

The government departments involved in the implementation of ADEP and ATDC were identified through the internet as the DTIC, DFFE, and FSDARD. The first telephone contact was made with the Departments to request participation. Subsequent to this, an email requesting the completion of a survey was sent to the contact details provided on the website.

The research used a sampling framework of 33 participants and the officials from the each of the three departments mentioned above to achieve the objectives of the study. However, only 18 farmers participated in the study, while data from all three implementing departments were obtained. The number of farmers who participated represented 55% of the sample size of 33 farmers, and 100% of responses were obtained from the implementing departments. Various reasons were provided by the farmers who did not want to participate, which included: farm closure; a change of aquaculture farm operation to other products/services; illness; and lack of time and interest.

Prior to performing the data analysis, data cleaning was conducted. This included creating a data set and entering the responses in Microsoft Excel, assigning each respondent farmer with a unique ID number, from 1 to 18. Data was collected based on the following categories:

Demographics of individual farm owners – the variables used under demographics were both continuous and categorical, comprising gender, age range, race, highest qualification attained, aquaculture experience/skills, and aquaculture association membership.

Farm operations – in order to obtain results on how small-scale operate their farms, variables such as type of species farmed, culture system, total production quantity per annum, availability of markets, other products offered on the farm, access to capital, and value of the farm were examined.

Government support programme – this aspect was analysed in order to determine whether small-scale farmers were aware of and benefited from the government support programmes. To measure the needs of small-scale aquaculture farmers and assess whether these have been appropriately and sufficiently provided by the relevant government programmes, a Likert scale was used to collect data and determine the degree of appropriateness and sufficiency. The Likert scale was developed so as to measure attitudes by Rensis Likert in 1932 (Sullivan, 2013). Sullivan (2013) further indicated that the Likert scale is normally set on a 5- or 7-point ordinal scale, which is used by participants to rank their level of agreement or disagreement with a statement. The Likert scale can be utilised to measure the service or product analysis as to whether the customer is satisfied or dissatisfied with specific goods or services. For this reason, the Likert scale was utilised as a suitable tool for measuring the appropriateness and sufficiency of government support made available to small-scale aquaculture farmers.

According to Mcleod (2008), the Likert scale has a number of advantages, one of which is that it does not require a simple ‘yes’ or ‘no’ response to a question from the respondent and rather allows for

degrees of views to be recorded. SmartSurvey (2022) further shows that the main advantage of a Likert Scale is that its questions are easier to understand, as it utilises a common process of collecting data. Data collected through a Likert scale makes it easier to draw conclusions from, formulate results, prepare graphs from the responses, and compile reports. One of the disadvantages of a Likert scale, as described by SmartSurvey (2022), is that, since Likert scale questions use a scale, respondents are not allowed to remain neutral in their answer, and are usually obliged to answer an 'either-or' opinion.

In terms of the implementing departments, the data collected regarding the relevant programme was based on the scope of the study. The department involved in implementing the ADEP was identified through the internet, which indicated that the ADEP was launched and is administered by the Department of Trade, Industry and Competition (DTIC). An email request to complete a survey was sent to the contact details provided on the DTIC website. A questionnaire was then prepared and sent to the Department. The questionnaire assisted in collecting primary data on the progress and in ascertaining whether the identified support programmes have reached their targets and/or objectives. The data requested covered the number of small-scale farmers who had applied for support from the programme per annum, the number of farms supported, the number of farmers who declined the rationale, the effect of the programme on the development of small-scale farms, and the challenges encountered. The data collected from the public sector regarding small-scale farmers enabled the researcher to examine the appropriateness and experiences of the programme in detail, from the implementer's point of view.

Similarly, the departments responsible for the execution of ATDC are in collaboration between the DFFE and FSDARD. Both departments were approached, and surveys were sent to them. Data on the support programme focused on information on the programme objectives and targets, the eligibility criteria, application processes, and their effectiveness. Secondly, focus was placed on the impacts of ATDC on the overall sector and small-scale aquaculture farmers. In order to determine whether the training and skills development provided by the government assisted in the development of small-scale farmers, the study focused on the number of farmers who had benefited from the intervention.

In terms of the 4th specific objective, which is "to benchmark the support programmes for small-scale aquaculture farmers in South Africa against similar programmes," only secondary data was collected by means of an extensive review of the literature and systematic reviews were made. This study also focused on government support programmes in developing countries with successful aquaculture sectors. The broader literature shows that China is the world's largest contributor to global aquaculture production and that Egypt is the largest contributor to Africa's aquaculture production. The literature further revealed that the aquaculture sectors of both countries consist mainly of small-scale aquaculture producers, with China over the years having been able to successfully graduate small-scale aquaculture to commercial aquaculture, with extensive support from the government. For this reason, both China and Egypt were selected for the purposes of this study.

A systematic review of research was conducted on the aquaculture sectors in both China and Egypt to identify the status quo of the sector in each country and to identify relevant factors that contributed to and supported their move from small-scale to commercial aquaculture, and the development of their sector. Obwanga *et al*. (2018) showed that accomplishing this would necessitate having knowledge of the key opportunities, strengths, threats, and weaknesses in the countries under study.

3.5.2 Data analysis

Regarding the first, second and third specific objectives, the study responses captured in Microsoft Excel were imported into SPSS analysing software. According to IBM (2019), the SPSS comprises a robust statistical software platform with an intuitive interface and a range of features that facilitate the faster extraction of actionable insights from data. IBM SPSS Version 29.0.1.0 was used to analyse data, and an automatic recode was used to convert text or string responses into numeric responses. Frequency distribution was conducted through the SPSS to analyse and determine the occurrence or regularity and frequency distribution of each small-scale aquaculture response. This enabled the researcher to determine the severity of, and measure how often or how commonly each response was in the sample size, therefore enabling the researcher to achieve the specific objectives of this study. Frequency distribution in statistics is defined by Young (2020) as providing a depiction of the number of observations taken during a certain interval, whether graphical or tabular. The interval size is determined by the objectives of the analyst and the data being analysed. With regard to this study, tabular displays in the form of tables and graphics were prepared.

The primary goal for the fourth specific objective is to examine strategies for fostering growth and the transition from aquaculture on a small scale to a commercial scale. To achieve this, a comparative study was conducted, focusing on factors contributing to the successful transition to commercial aquaculture in China and Egypt, highlighted factors and lessons learned that might also be suitable for the South African context. Obwanga *et al*. (2018) conducted a similar study exploring how Egypt, Nigeria and Ghana shifted from subsistence to commercial aquaculture farming. The findings from their study identified insights into the successes and lessons learnt by these three countries that might have been suitable for the Kenyan context. The current study adopted a similar approach to achieving the objective in question.

Comparative analysis was used to compare the support programmes or models in the identified countries with the support programmes implemented in South Africa. A comparative analysis is defined as a method used to compare similar items with other items to identify their differences and what they have in common (Rollo, 2022). Comparative study, according to Drobnič (2014), primarily entails describing and elucidating the similarities and differences of circumstances or outcomes among sizable social units, often regions, nations, societies and cultures. Furthermore, its goal is to search for similarity and variance among the components of analysis. The literature revealed that the development of an aquaculture sector not only depended on government interventions, and that other relevant factors also

influenced the development of the aquaculture sector in these countries. In order to accomplish this analysis, a thorough literature analysis was carried out to pinpoint the critical elements that enabled China and Egypt to progress from small-scale aquaculture to commercial aquaculture.

Comparative analysis was used to compare the support programmes in the identified countries with the support programmes implemented in South Africa. The main objectives of the comparative country study are:

a) twofold in nature: first, to draw insights from the aquaculture sectors in China and Egypt; and second, to pinpoint pertinent variables that shaped the growth of these sectors.
b) In order to perform this comparison, a survey of the literature was conducted in order to determine the main drivers of China's and Egypt's shift to the commercial aquaculture sector. The results of the literature review were examined and summarised.

Literature analysis was conducted to classify the crucial factors reinforcing the change to the commercial sector in China and Egypt. Accordingly, the findings of the literature assessment were analysed and presented. A comparative analysis between China, Egypt and South Africa was conducted, with the intention to review the characteristics of the support programmes adopted by other countries to support small-scale aquaculture development, and the results were presented in a tabular format.

3.6 Ethical considerations

Ethical considerations in research are conventional principles that direct study designs and procedures, according to Bhandari (2022). According to Hammersley and Traianou (2012), ethics can also be defined as a system of values that help us discriminate between good and wrong. When gathering information from subjects, researchers must always follow certain behaviour guidelines (Bhandari, 2022). The University of Pretoria adheres to ethical standards, which served as the basis for our investigation. The research procedures included adherence to and completion of the ethical approval process of the University of Pretoria. The purpose of obtaining the ethics approval letter was to ensure that the research was conducted in accordance with the University's ethical guidelines.

3.7 Informed consent

The purpose of securing informed consent from the participants is to ensure that participants can take part in the research study freely after being given complete information about what the research involves and about the benefits for them in taking part, as well as advice that, before they can participate in research, they should give their consent (Oxford, 2021). The method for obtaining informed consent ensures that study subjects willingly engage in research after being fully informed of all pertinent risks and benefits (Manti & Licari, 2018). According to Xu *et al.* (2020), the intention behind gaining permission is for individuals to willingly participate in research after being informed of the nature of their

involvement. Before beginning with the study, the respondents were contacted and briefed on the goal or purpose of the research, as well as on who would have access to their information, and consent forms to participate were provided.

3.8 Anonymity and data confidentiality

The degree to which the source of a message can be detected is known as anonymity, according to Scott (1995). The degree of anonymity varies from very high, where identifying the source is almost impossible, to none, where identifying the source is simple or has already been done.

Bos (2020) has indicated that, in research ethics, confidentiality involves a commitment from the researcher to ensuring that the use of the data obtained from participants respects their dignity and does not violate the interests of participants. In addition, confidentiality can apply to circumstances where an investigator is aware of the identity of a respondent, however, ensures that precautions are taken to keep that information hidden from outside parties.

According to Bos (2020), the concepts of anonymity and confidentiality are correlated, although they vary in some important respects, where, while ‘confidentiality’ refers to an agreement between the respondent and the researcher not to reveal certain personal information; and ‘anonymity’ concerns the initial data gathering. Researchers who wish to secure anonymity do not record any identifying information, thereby making it a safer guarantee. On the other hand, identifying information is recorded for those who would rather maintain ensure anonymity, while the information is nevertheless kept private. Both anonymity and confidentiality are important in research, and were offered in this study. To achieve this, a unique descriptor or ID number was allocated to each participant/respondent in order to hide the respondent’s personal information. This ensured that the source of information identity remains protected.

3.9 Summary

This chapter has illustrated the research methods and procedures utilised in this study to collect and analyse data to determine the appropriateness and sufficiency of public support available for small-scale aquaculture in Gauteng Province. Primary and secondary data were collected using questionnaires, and a systematic review was conducted to examine previous studies on the development of aquaculture in China and Egypt. A sample of 33 small-scale farmers and three government departments was selected, although only 55% of farmers and 100% of departments ultimately responded. Frequency distribution and comparison analysis were used to determine the appropriateness and sufficiency of public support. The results will be presented in tabular and graphic form in the next chapter.

CHAPTER 4:
RESULTS AND DISCUSSION

This chapter describes the results derived from the survey conducted among aquaculture farmers in Gauteng, and the three government departments implementing the government programmes, ADEP and ATDC. In addition, the chapter describes the results of the comparative analysis made between the two successful, large aquaculture countries, China and Egypt, with South Africa. The initial section of this chapter will provide results on demographics and the way in which small-scale aquaculture farmers operate their farms.

4.1 Demographics and farm operation characteristics of small-scale aquaculture

4.1.1 Demographics of small-scale aquaculture

Table 4.1 shows the demographic distribution of small-scale aquaculture farmers included in the study. The table indicates that, of the sample of 18 farmers who participated in this study, the majority of the farms were owned by males, with 83,3% being owned by males, and 16,7% being owned jointly by females and males. None of the participants represented a female-owned farm. The results support the study by Phosa (2018), where the majority of farms at 73% were owned by males and only 27% were owned by females. This shows that most of the small-scale aquaculture farmers are males, and in the case of this study, where there is female involvement in the ownership structure, it is usually in partnership with a male. In terms of age distribution, the study found that no young adults within the age range of 18–35 owned an aquaculture farm. The majority of farms were owned by individuals in the age range of 46–55 years, at 50%, followed by 56+ at 38,9%, and only 11,1% within the age range of 36–45. Similarly, the study by Phosa (2018) concurs with these results, because it shows that the highest percentage of small-scale farmers at 47% were between the age of 41-50 years, followed by the age of 50+ years with 33 percent. Only 20% were between the age of 30-40 years and none from the age range between 18-30 years. This indicates that greater interest in aquaculture farming ownership was shown by males, who are older adults (36+ years).

The race distribution of small-scale aquaculture farmers reflected in Table 4.1 indicates that the majority of farmers or aspiring farmers were black, at 50%, followed by white farmers at 38,9%, and only 5,6% of the participants was coloured and Indian. Operating an aquaculture farm requires technical know-how (Njokweni, 2015; AgriSETA, 2021). Aquaculture is a business that demands skill, technology, and knowledge (FAO, 2017). It is evident from previous studies that the field requires having an educated background. The results show that none of the participants received no education. The majority, at 33,3%, had post-graduation qualifications; 27,8% had degrees; 22,2% had a diploma; and only 16,7% had a matric certificate. Half (50%) of participants had more than five years of experience in aquaculture, while 22,2% had none, which is attributable to the fact that some farm owners employ a farm manager to undertake the management of day-to-day operations. A minority 11,1% participants

had three–five years of experience and formal aquaculture training, respectively, and only 16,7% had 1–2 years of experience. Munthali *et al*. (2022) stressed the importance of education in aquaculture, pointing out that literate farmers are more likely to absorb and apply innovations, technology, and new and improved aquaculture management techniques. The majority of participants, numbering 66,7%, were affiliated with an aquaculture association, while 27,8% were not members of any association. This demonstrates the importance of associations or forums in the field of aquaculture.

Table 4.1: Small-scale aquaculture demographics (n=18)

Variables	Description	Frequency	Percentage (%)
Gender of owner	Female ownership	-	-
	Female & male ownership	3	16,7
	Male ownership	15	83,3
Age range	18-25	-	-
	26-35	-	-
	36-45	2	11,1
	46-55	9	50,0
	56+	7	38,9
Race	Black	9	50,0
	Coloured	1	5,6
	Indian	1	5,6
	White	7	38,9
Highest qualification obtained	Degree	5	27,8
	Diploma	4	22,2
	Matric	3	16,7
	None	-	-
	Post-graduate qualification	6	33,3
Aquaculture training/experience (yrs)	1-2 years	1	5,6
	3-5 years	2	11,1
	5+ years	9	50,0
	Formal aquaculture training (years)	2	11,1
	No aquaculture skills/experience	4	22,2
Member of Association	No	5	27,8
	Unknown	1	5,6
	Yes	12	66,7

Source: Data survey (2023)

4.1.2 Farm operation characteristics

In South Africa, aquaculture is at its infancy and is a small sector, with a low numbers of farmers. The study sample included active farms, closed farms, and aspiring aquaculture farmers at advance stages of starting their own farms. This study also examined the operations of the farm in order to determine the sustainability of an aquaculture farm.

Table 4.2 shows that, of the 18 participants, 56% were operating farms, and 44% were not operating farms. Based on the results, of the eight participants, 87% had not yet started with their operations and 5,6% had closed the farm owing to load shedding. The major issue for the 90% respondents not in operation comprised finance and difficulty in getting compliance documents in place, particularly an EIA. In addition to these aspects, 11,1% respondents indicated that they did not own land.

All of the participants (100%) who were in operation had been operating their farms for more than five years. The preferred method of farming was the Recirculating Aquaculture System (RAS), at 78%, followed by ponds at 17%, while 5% respondent used aquaponics. This contradicts earlier studies, which reported that small-scale aquaculture farmers rely mainly on simple earthen ponds as a method of farming. Sen (1996) states that the cultivation of fish in earthen ponds, with substantial or semi-intensive management, is known as small-scale aquaculture, within the context of Eastern and Southern Africa. During the interviews conducted as part of this study, the observations made indicated that RAS was used interchangeably with aquaponics, and farmers indicated that they use RAS with hydroponics. Aquaponic systems are used to grow both plants and fish, and endeavours to achieve a healthy life balance between the two. As a result, 78% of farmers grew or are intending to grow vegetables to supplement their aquaculture income. This is in line with literature, which indicated that small-scale aquaculture may be combined with other aspects of farming, such as crop and livestock farming, thereby benefiting each other (Expert Consultation on Small-Scale Rural Aquaculture, 1997). The experts further stated that many farmers operate small-scale aquaculture as secondary and not primary activity and that it is used to supplement income, provide a source of additional food, as well as a strategy to diversify. However, this was not true in the case of small-scale aquaculture farmers in Gauteng, where the respondents used integration farming methods where fish farming became a primary business activity, and other farming activities became secondary in order to supplement their aquaculture income. This contradicts the voice of leading experts on small-scale rural aquaculture (1997). Other services provided by the farmers included aquaculture training, consulting, and aquaculture system design and construction.

In terms of species choice, tilapia was a preferred species, at 67%, followed by trout at 22%, and mixed species (mainly tilapia and catfish) at 11 percent.

Table 4.2: Farm operation characteristics of small-scale aquaculture (n=18)

Variables	Description	Race				
		Black	Coloured	Indian	White	Total
Gender of owner	Female & male	2	0	0	1	3
	Male	7	1	1	6	15
Are you currently in operation	No	5	1	1	1	8
	Yes	4	0	0	6	10
Number of years in operation (yrs)	5+	4	0	0	7	11
	Not yet started	5	1	1	0	7
Farming system preferred	Aquaponics	0	0	0	1	1
	Ponds	2	0	1	0	3
	Recirculating Aquaculture System	7	1	0	6	14
Fish species	Mixed	1	0	0	1	2
	Tilapia	6	0	1	5	12
	Trout	2	1	0	1	4
Other income-generating services	No	1	0	1	2	4
	Yes	8	1	0	5	14

Source: Data survey, 2023

4.2 Challenges faced by small-scale aquaculture farmers

Table 4.3 presents the key challenges confronted by small-scale aquaculture farmers, as identified by the farmers. It is clear that 89% of respondents indicated that access to funding was a major issue in aquaculture. Fourteen (78%) stated that the sector was highly regulated and that obtaining relevant permits, licences and authorisations is complex. Skills came in third, with 61% noting the lack of skills by new farmers and the government employees' lack aquaculture expertise to provide appropriate guidance on aquaculture. High operational costs was identified by 50% farmers as a challenge. Electricity, feed and labour, among others things, were identified as the main contributors to high

operational costs. The study findings further show that 39% of respondents identified lack of access to land as comprising one of the contributing challenges. Land was mentioned as a challenge as it is costly to buy or rent/lease. In addition to this, new entrants are unable to access finance owing to their lack of land, which was mostly required as a source of collateral security for obtaining finance. A proportion of 39% of respondents mentioned the lack of a market as one of the challenges, while 33% identified the high capital required to start a farm as a challenge, with 28% pointing out that loadshedding presented a challenge. A proportion of 28% of respondents identified quality inputs and research and development respectively constitute challenges, while 17% and 6% respectively identified cheap fish imports as being due to the lack of proven production systems, and crime, as challenges that hinder growth in the sector. None of the respondents mentioned infrastructure as being a challenge for aquaculture development.

Table 4.3: Challenges faced by small-scale aquaculture farmers (n=18)

Challenges	Number of Respondents	Percentage (%) of Respondents
No access to funding	16	89
Highly regulated	14	78
No skills	11	61
High operational costs	9	50
Lack of access to land/ sea space	7	39
No market access	7	39
High capital expenditure	6	33
Energy crises	5	28
Lack of quality inputs	4	22
Research and Development	4	22
Lack of proven production systems	3	17
Cheap Fish Imports	3	17
Theft	1	6
Lack of Infrastructure	-	-

Source: Data survey 2023

4.2.1 Lack of access to funding

The results indicate that 89% of the participants (Table 4.3) identified the sparse availability of funding as a major challenge to small-scale aquaculture development, which supports the results of previous studies. As the literature has shown, small-scale aquaculture farmers lack access to funding due to of the credibility and collateral required for them to gain access to formal credit (European Commission, 2017). In addition to this, aquaculture is capital intensive because of its technological nature (DAFF, 2013a). Most of the respondents specified that establishing a fish farm can cost between R1 million and R5 million, depending on the production system used, and this excludes working capital. This contradicts what Muir (2001) indicated, to the effect that small-scale aquaculture requires limited amounts of capital and operating expenses, and what Sen *et al*. (1996) stated, where they note that small-scale aquaculture requires little funding, primarily for the purchasing of fingerlings and possibly for the building of ponds, within the context of Eastern and Southern Africa. Lichtkoppler (1993) and Njokweni (2015) indicate, however, that aquaculture requires a large amount of capital and because it is a technology-driven sector, where significant and ongoing capital investment is needed.

Operating a farm requires finance to buy seed, feed and electricity, which prove costly. Considering the time that a fish takes to grow to market size, a farmer is required to pay more on the operational costs without generating any income. An example was provided about trout fish, which take eight months to reach a market size of 350 grams. For this reason, it was a challenge to obtain finance, even with extensive track records. Aquaculture is not only a capital-intensive industry, but is also technology-driven, and for this reason, it requires high capital investment and also takes longer for investors to realise their return on investments. To deal with this challenge, respondents indicated that they have secondary businesses, such as vegetable farming, training, consultancy, aquaculture system design and building, to supplement the fish farm.

The three departments also identified lack of funding as a challenge among small-scale farmers, alluding to the fact that financial institutions are unwilling to offer funding due to the risks associated with aquaculture. This corroborates the Operation Phakisa Aquaculture Lab Report (2014) and Basu (2019) where they indicate that the capital-intensive nature of aquaculture presents a distinct set of risks, and that farmers encounter the additional difficulty of attracting capital into a relatively new industry. Therefore, the implications of lack of access to finance by these farmers includes inability to establish a farm or invest in appropriate machinery and species which require high capital investments. Additionally, inability to operate the farm due to the core issues facing all fish producers, which are the high costs of input including feed, energy and fingerlings (Van Duijn *et al*., 2018). This becomes a barrier to development.

4.2.2 Aquaculture is highly regulated

About 78% of the respondents indicated that aquaculture is over regulated, and this agrees with the findings of the previous studies. The respondents highlighted the point that obtaining authorisations was a most disjointed exercise, where there are numbers of permits and licences required before starting to operate a farm, and the processes to obtain these compliance documents are complex, lengthy, and costly. This substantiates what previous studies have reported on uncoordinated items of legislation (Phosa, 2018), on the complex legislative and regulatory environment (DFFE, 2019b), and on regulatory barriers in the sector (Madibana *et al.,* 2020). Respondents indicated that getting compliance in place is highly frustrating, difficult, prohibitive, negative and disabling. The Operation Phakisa Aquaculture Lab Report (2014) states that, in order to formalise the intention to operate an aquaculture farm, the potential farmer will need to apply for 28 permits and licences, which are costly to obtain. The process to obtain the authorisations is also lengthy, and can take up to three (3) years (1100 days) (Operation Phakisa, 2014). Without compliance documents, these farmers are unable to start their farming operations, access funding, are not able to supply formal markets, and are unable to expand their operations, which forces them to remain small in scale. It is costly to appoint a private independent practitioner to conduct a basic assessment or full EIA, where achieving compliance was convoluted, with most people abandon the process. This shows that the extensive red tape created through over-regulation hinder new entrants and hinders the sector from developing.

In terms of aquaculture regulations, the three departments involved in the study agreed that the sector is over-regulated, presenting a major challenge towards small-scale development. However, the respondents indicated that have been major efforts to streamline regulations to reduce barriers to entry and create a conducive regulatory environment for aquaculture through the Operation Phakisa and by developing the Aquaculture Development Bill.

4.2.3 Skills and technical support

As shown in Table 4.3, 68% of the respondents identified skills and technical support as comprising one of the major challenges, as has been noted in previous studies. According to the respondents, the underdevelopment of small-scale aquaculture was also attributable to lack of appropriate skills in aquaculture and business, for both farmers and government officials involved in aquaculture. There are limited extension services available, while the services and advice the officials provide remain limited. This is confirmed by AgriSETA (2021) to the effect that, although the extension officials are the main points of contact for farmers, the guidance they render is not always suitable and appropriate, and might result in complications. For this reason, many small-scale ventures fail. According to Njokweni (2015), aquaculture requires highly skilled labour, because it is highly technical and capital-intensive. Rouhani and Britz (2004) added that aquaculture projects mainly fail because they were not provided with ongoing technical support. Aquaculture farming requires not only one set of skills, but rather requires special skills owing to its technicality. AgriSETA (2021) agreed that, in the case of small-scale farmers,

there is a need for training in technical skills (water quality, nutrition and breeding) and management skills (supervisory skills and farm management), which are required for successful aquaculture operation.

Lack of skills and inadequate extension services were identified by all three departments as major challenge to small-scale aquaculture development in South Africa. This skills gap manifested in several ways which includes limited access to training and access to training centres such as the ATDC, which seems insufficient to reach a geographically dispersed small-scale farmer population. In addition, private training options can be expensive, placing a significant financial burden on small-scale farmers. The limited number of aquaculture extension officers hinder effective knowledge transfer and technical support for small-scale farmers. This lack of ongoing guidance can be detrimental to farm success, due to the absence of such support. The combined effect of these factors creates a significant barrier to entry and undermines the long-term sustainability of small-scale aquaculture operations.

4.2.1 High operational costs

Table 4.3 shows that 50% of respondents indicated that it is very costly to operate an aquaculture farm, especially a small-scale farm, because the overheads are similar to those of larger operations, owing to the economy of scale. Moreover, individual small-scale farmers are unable to expand their production due to regulatory requirements, which require an environmental impact assessment (EIA) to be done when producing more than 20 tons of fish. Inputs such as feed, seed, labour, chemicals, distribution, and electricity, as well as fuel for generators because of electricity loadshedding, are contributing to higher production costs. This becomes a barrier to development, since, as stated by Van Duijn *et al.* (2018), the two main issues facing all fish producers are the high cost of input like feed and fingerlings and the difficulty in obtaining loans. Because of this, it is becoming increasingly more difficult to operate on a small-scale, while receiving lower returns.

4.2.2 Lack of access to land/sea space

The results indicate that 39% of respondents (Table 4.3) identified the lack of access to land as a burning issue, which supports the results of previous studies. The point was highlighted that access to suitable land proves itself to be a challenge, and in cases where land is available, it is costly to purchase or lease. The Operation Phakisa (2014) and DAFF (2012) also reported a lack of suitable land and sea space as one of major challenges in the sector, and this could be attributed to fact that aquaculture is often excluded from spatial planning and is most often not prioritised. Njokweni (2015) indicated that difficulties in finding a suitable location for aquaculture farming and restricted access to suitable waters, sea space, and land are among the challenges encountered by farmers. Madibana *et al*. (2020) found that aquaculture, as with other farming activities, requires land, and that without it, the emerging farmers will have restricted roles within aquaculture development. Furthermore, the lack of land has resulted in a number of respondents being unable to secure funding.

Limited access to land and sea space emerged as a critical barrier to small-scale aquaculture development, as also identified by all three departments. The respondents indicated that this issue stems from several factors, such as competing land uses, wherein South Africa faces a growing demand for land for agriculture, housing, and industrial development. This competition often pushes small-scale aquaculture farmers to less desirable locations, with limited access to water resources or infrastructure. Another issue identified was administrative complexities of securing land tenure, especially for sea space through aquaculture rights, can be a complex and bureaucratic process. Small-scale farmers may lack the resources or knowledge to navigate these procedures effectively. Operation Phakisa Aquaculture Lab Report (2014) highlight the challenges faced by small-scale fishers in obtaining permits and licenses, and similar complexities likely apply to acquiring aquaculture rights. Furthermore, high purchasing costs or lease costs can be prohibitive for small-scale farmers with limited financial resources when land or sea space is available. This can hinder their ability to secure locations suitable for sustainable aquaculture practices.

4.2.3 No market access

As shown in Table 4.3, 39% of respondents pointed out that gaining access to market and market penetration is a challenge, as noted in previous studies. This was also found by Mwanja and Nyandat (2013), who reported that a lack of well-organised markets for small-scale aquaculture in Malawi was a problem. DAFF (2014) also identified access to and availability of markets as a challenge. The findings indicate that competition from cheap Chinese imports makes it difficult for farmers to sell fish at a viable price. Consumers prefer cheaper fish and local small-scale farmers are not able to sell at these prices due to higher operating costs for production, and therefore are unable to compete with the imported fish. In addition to this, most South Africans are not fish eaters, especially of freshwater fish, which limits demand. The findings also show that it is difficult to sell to formal markets, because of the quantity of supply required on a regular basis, and also because of the Global GAP, which are imposed by government on the retailers. This makes it difficult to buy from small-scale farmers who are not registered according to Global GAP, as the retailer would be fined. It was further indicated that registration for Global GAP is costly, and requires about R90 0000 to obtain.

4.2.4 High capital expenditure

About 33% of the respondents, as shown on Table 4.3, highlighted the point that starting an aquaculture farm is expensive, as reported by previous studies. Funds are required for buying land, conducting a feasibility study, putting compliance authorisations in place, system design, construction, training of employees, and mentorship. Njokweni (2015) also found that high capital investments in terms of machinery and species development are required for effective aquaculture. For example, an RAS and tunnel costs a minimum of R1 million to construct, and where annual production is to be at 20 000 kg (20 tons) and produce is to be sold at R50 per kg, it would take long time for the farm to reach a break-

even point. The findings indicated that most of the aquaculture operations do not grow out stock, but sell fingerlings, provide systems and training, and sell feed for small-scale aquaculture. Small-scale farmers tend not to have hatcheries, but serve as grow-out facilities and take or absorb the risks associated with grow out operations, such as high costs of production and marketing. It was indicated that small-scale aquaculture is usually not sustainable, while larger scale operations are sustainable. For example, Chinese aquaculture is sustainable because it operates large farms, and each farm incorporates the entire value chain, from breeding to marketing or distribution.

High capital expenditure was also identified by all three departments as a major obstacle to small-scale aquaculture development. The respondents indicated that establishing an aquaculture operation requires significant investment in infrastructure (ponds, tanks, recirculating systems), equipment, and fingerlings. These initial costs can be overwhelming for small-scale farmers, who often operate with limited financial resources. Due to high capital expenditure there is a significant reduced participation in the sector. The financial barriers effectively exclude many potential small-scale farmers from entering the sector, hindering its overall growth and diversification. Furthermore, due to high capital expenditure farmers may adopt unsustainable practices, such as using poor quality inputs and technology to cut costs, which can jeopardise the long-term viability of the sector and harm the environment.

4.2.5 Load shedding/energy crises

Table 4.3 indicates that 28% of respondents identified electricity loadshedding as a challenge for small-scale aquaculture. Loadshedding is a recent issue affecting business, when compared with other challenges. The aquaculture fish systems, such as RAS, require energy to operate and without energy, the entire stock would be lost. In the worst-case scenario, this could lead to farm closure. As a measure to deal with loadshedding, the findings show that farmers use generators, which increase operational costs. The respondents indicated that the government should provide support in terms of alternative energy, such as solar power. James (2019) has indicated that, for RAS, a continuous flow of water is essential to support aquatic life, and when loadshedding occurs and filtration systems stop, causing microorganisms to suffocate, and releasing toxins into the water that can poison fish.

4.2.6 Lack of quality inputs

Some 22% of respondents (Table 4.3) stated that it is difficult to access quality inputs, such as seed and feed, and when they are available, they are costly, especially in the case of raw ingredients for feed. This substantiates what Mwanja and Nyandat (2013) reported regarding poor-quality fish seed or fingerlings and inadequate fish feed affecting small-scale farmers in aquaculture, which is attributable to the lack of availability of quality seed and feed and the cost of obtain quality inputs. Furthermore, the respondents indicated that, in terms of seed, if fingerlings are of low quality, the entire chain up to the grow-out stage would fail, and as such, the hatchery holds the key to success or failure. If poor quality

fingerlings are supplied, the farmer would fail and the farm would eventually close. In terms of feed, most farmers wish to have the cost of feed reduced. If poor quality feed is introduced, the entire programme fails, resulting in low-quality fish with slow growth rates.

4.2.7 Research and Development

As presented on Table 4.3, 22% of respondents noted that the sector's lack of research and development presents a challenge, and contributes to the underdevelopment of small-scale aquaculture. For this reason, it is difficult to gain access to genetically correct species, as there is limited availability of genetics and production systems suitable for South African conditions. This was also identified by the government through NASF (2012) and collaboration between the private, public sector and academia through Operation Phakisa Aquaculture Lab in 2014, which reported that the R&D is fragmented and disjoined in the country, and that therefore more research is required to be done on technology and species development to promote an efficient and sustainable sector.

4.2.8 Lack of proven production systems

The results indicated that 17% (Table 4.3) of the respondents identified the lack of proven production systems as a challenge and a hindrance to small-scale aquaculture development. The findings indicated that South Africa has been inundated with individuals selling unproven aquaculture systems, and that most fish farmers are using systems that have been proven to fail as viable fish farming methods. These touted production systems are promoted and implemented, only to fail in the short term. This has resulted in the closure of many small-scale farms, owing to their resulting lack of productivity, which may contribute to and cause the failure of the aquaculture sector. Tried and tested self-sustaining aquaculture production systems are required for successful aquaculture farms and a successful sector overall.

4.2.9 Cheap Fish Imports

As shown on Table 4.3, 17% of the respondents pointed out that cheap fish imports, mainly from China, are a challenge to locally produced fish. These products have saturated the South African markets, competing with local products. This requires protection from the government to safeguard the local fish businesses from the foreign competition. Britannica (2023) defines 'protectionism' as a policy protecting local businesses against foreign competition by implementing measures such as tariffs, import quotas, subsidies, or other restrictions that are placed on the imports of foreign competitor products.

4.2.10 Crime

According to Table 4.3, only 6% of the respondents identified theft as being a challenge. Theft, however, is common in urban to semi-urban areas, where security on farms is low to non-existent. Phosa (2018) also identified theft as being one of the challenges affecting rural fish farmers in Limpopo Province, and to deal with this, the study recommended a partnership between the public and private sectors to assist poor farmers to build security fences.

Figure 4.1 reflects a graphical summary of the challenges faced by farmers. The major challenge in this regard is access to funding, at 18%, followed by regulations and lack of skills at 16% and 13%, respectively. The least mentioned challenges are the lack of a proven production system at 3% and cheap fish imports at 2 percent. Infrastructure was not a concern for any of the respondents.

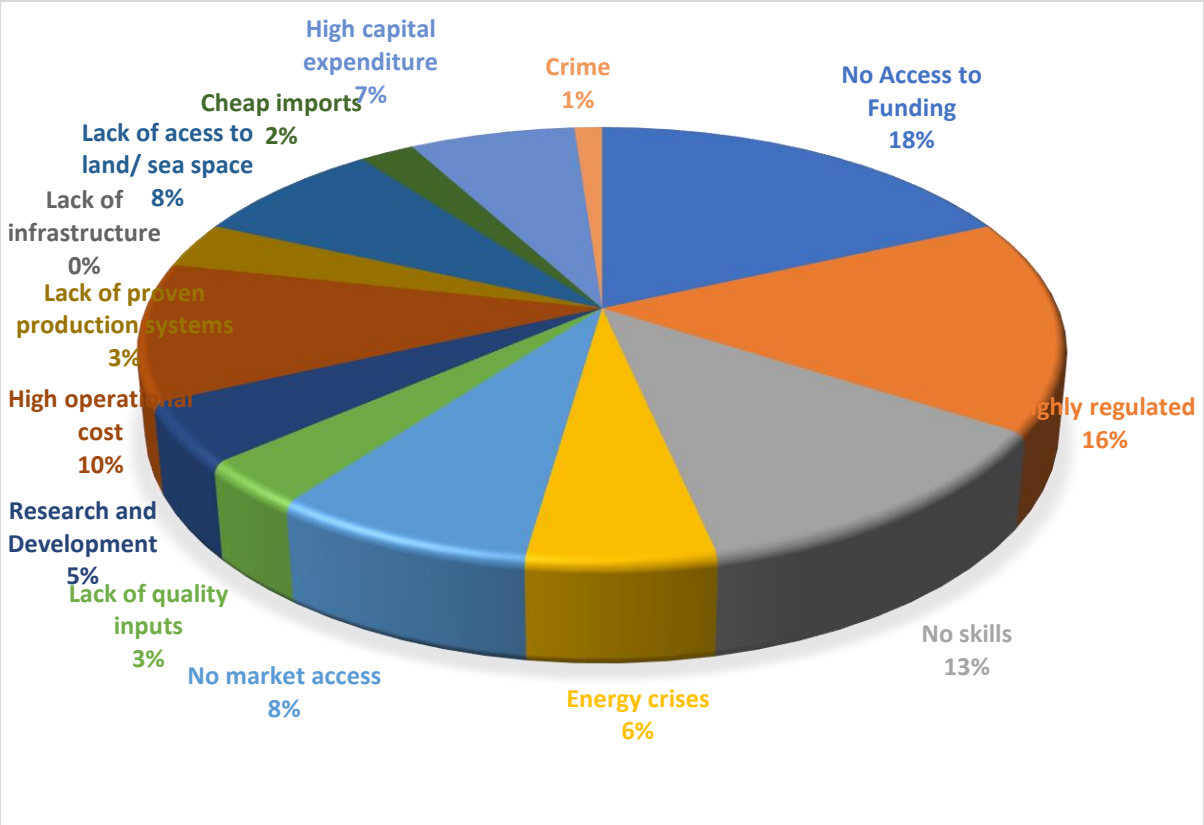


Figure 4.1: Challenges faced by small-scale aquaculture farmers (n=18)

Source: Data survey, 2023

4.3 Appropriates and sufficiency of financial support through the Aquaculture Development and Enhancement Programme (ADEP) towards small-scale aquaculture development

The results described were obtained based on the analysis of the ADEP support programme. To assess and determine the degree of appropriateness and sufficiency of ADEP to provide financial support to small scale aquaculture, a Likert scale was utilised. This study utilised a 5-point ordinal Likert scale, where 1 indicated 'highly not appropriate or sufficient', and 5 represented 'highly appropriate or sufficient'. The results obtained were presented in tabular form.

4.3.1 The appropriateness of ADEP

In terms of the appropriateness of ADEP for supporting small-scale aquaculture development through financial support, Table 4.4 paints a concerning representation. A significant majority 61.1% of farmers indicated that ADEP is "highly inappropriate" as a financial tool. The following issues were identified by the respondents:

a) ADEP minimum requirements and criteria to qualify

Farmers indicated that ADEP is "highly inappropriate". This perception stems from the programme's criteria and requirements, which small-scale farmers find difficult to achieve. These requirements include securing owner contributions, obtaining land ownership or lease, and complying with regulations – hurdles that often exclude small-scale farmers from accessing the programme. As a result, ADEP tends to favour larger operations with the resources to secure loans, own land, and manage extensive compliance documentation.

b) Legislative requirements

Farmers indicated that they indeed find it difficult to access ADEP, because small-scale aquaculture farmers often struggle to comply with the applicable legislative requirements for aquaculture, such as EIAs, licenses, and permits, which are mandatory before applying for or receiving approved funds. This difficulty stems primarily from the high costs associated with obtaining these compliances and the complex paperwork involved. Research confirms the intricate, time-consuming, and expensive nature of the aquaculture regulatory environment (Operation Phakisa, 2014; Phosa, 2018). As a result, the requirement to submit compliance documents during the funding application process presents a significant hurdle for small-scale farmers.

c) Viable production scale

Another significant hurdle identified by farmers was meeting the production scale required for viability and sustainability. The Department of Agriculture, Forestry and Fisheries (DAFF, 2018b) has conducted

species-specific feasibility studies outlining minimum viable production scales for different species and farming systems. For instance, a Recirculating Aquaculture System (RAS) farming Nile Tilapia requires a minimum annual production of 73 tons at an average selling price of R62 per kg in order to be considered commercially viable. However, exceeding 20 tons of annual production triggers the need for an EIA, and farming invasive species necessitates additional permits. In order to avoid the complexities of EIAs and permits, many small-scale farmers opt for production below 20 tonnes. Unfortunately, this lower production volume, coupled with potentially lower fish prices, often leads to the rejection of their grant applications due to concerns about operational viability and sustainability.

d) Lack of start-up and operational costs

While 11% of respondents found ADEP to be "inappropriate" and "fairly appropriate," respectively, the dominant view is that the programme does not address the critical financial needs of small-scale farmers, primarily start-up capital and input costs. Their inability to secure private funding is further compounded by ADEP's requirement for applicants to have existing financial resources. Furthermore, a farmer applying for the grant is required to have a comprehensive bankable business plan and financial statements in place, among other things, proving the commercial viability and sustainability of their business. The literature review showed that most small-scale farmers lack bankable business and production plans (Madibana *et al*., 2020) would prove the viability and sustainability of the farm. A proportion of 5.6% of respondent viewed ADEP as “appropriate” and "highly appropriate" respectively, for developing small-scale aquaculture as it does to some extent cover lease costs, as well as inputs costs such as feed and mentorship, which are required and are essential for small-scale development.

Table 4.4: The appropriateness of ADEP (n=18)

Ratings for the appropriateness of ADEP to provide financial support to small-scale aquaculture	**Level of appropriateness**	**Frequency**	**Percentage**
	Very appropriate	1	5.6
	Fairly	2	11.1
	Appropriate	1	5.6
	Not appropriate	2	11.1
	Unknown	1	5.6
	Extremely not appropriate	11	61.1

Source: Data survey, 2023

4.3.2 The sufficiency of ADEP

In terms of the sufficiency of ADEP to provide financial support for the development of small-scale aquaculture, an examination of Table 4.5 reveals the ADEP's ability to sufficiently support small-scale aquaculture development. A substantial majority (61.1%) of consider ADEP "highly not sufficient" as a financial tool. This perception arises from the following factors:

a) Reimbursable funding structure

Farmers indicated that the ADEP is highly insufficient because the programme only reimburses or offers a percentage of a farmer's capital expenditures, therein failing to provide crucial start-up capital. Due to ADEP's reimbursement structure, farmers must independently arrange and finance approved aquaculture activities before claiming repayment from the programme. This upfront investment requirement, encompassing machinery, infrastructure, and other approved activities, proves particularly challenging for small-scale farmers, who – as research confirms – typically lack access to capital. Therefore, the programme's structure or funding model creates a barrier, as farmers cannot invest in aquaculture by sole means of which to then access the grant for reimbursement.

b) Cost-sharing structure

An additional 11% of respondents found ADEP "insufficient" due to its cost-sharing nature, consequently, where it falls short of covering the essential financial needs of small-scale farmers, while another 11% viewed it as "fairly sufficient." These respondents highlighted that ADEP primarily benefits those with existing financial resources or larger operations and excludes those who actually lack access to funding. This concern is echoed by existing beneficiaries, who reported leveraging funds from other businesses to establish their farms and qualify for ADEP reimbursement.

Despite these, Table 4.5 also shows 11.1% of respondents who perceive ADEP as sufficient and highly sufficient, respectively. These respondents value the programme's requirement for owner contributions as an indicator of a farmer's commitment. While those who perceived ADEP as highly sufficient indicated that for those who benefitted from it, it provided a cash flow boost and enables operational expansion or cost coverage.

Table 4.5: The sufficiency of ADEP (n=18)

	Level of sufficiency	Frequency	Percentage
Ratings for the sufficiency of ADEP to provide financial support to small-scale aquaculture	Highly sufficient	1	5.6
	Fairly	2	11.1
	Sufficient	1	5.6
	Not sufficient	2	11.1
	Unknown	1	5.6
	Extremely not sufficient	11	61.1

Source: Data survey, 2023

4.3.3 Funding requirements of small-scale aquaculture

The results shown in Table 4.6 highlight the amounts of start-up capital required to establish a farm, and the types of funding sources used by respondents to start their farms. The study findings indicate that an average finance amount of R4 615 713 is required in order to establish a small-scale aquaculture farm. The literature has substantiated that it is costly to start a fish farm (Njokweni, 2015; DAFF, 2013b). The table further shows that the maximum capital investment was R10 m, while the minimum was R10 000. The cheapest farm used ponds as a culture system and had the lowest capacity in terms of fish quantity per annum.

The results further show that participants used different funding sources to finance their farms, with 46% indicating that they used 100% own funding to start their farm, while 20% indicated that they used a combination of own funds and other sources. Furthermore, 20% of the respondents indicated that they received a certain percentage of grants, which they used in addition to either a loan or own funds. Only 7% of respondent indicated they used a loan and own labour.

Table 4.6: Funding requirements of small-scale aquaculture (n=18)

Source of Funding		Mean (R million)	No. of respondents	Median (R million)	Maximum (R million)	Minimum (R million)
No funds (%)	0	4,6	14	5	10	0,01
	100	4,8	4	5	9,3	0,11
Sweat capital (%)	0	4,9	17	5	10	0,11
	100	0,01	1	0,01	0,01	0,01
Own Capital (%)	0	3,2	8	3	9,3	0,01
	20	10	1	10	10	10
	50	5	1	5	5	5
	60	5	1	5	5	5
	100	5,4	7	5	10	0,11
Grant (%)	0	4,3	15	5	10	0,01
	40	7,5	2	7,5	10	5
	50	5	1	5	5	5
Loan (%)	0	4,4	17	5	10	0,01
	40	10	1	10	10	10

Source: Data survey, 2023

4.4 Appropriateness and sufficiency of skills development support services through the Aquaculture Technology Demonstration Centre (ATDC) towards small-scale aquaculture development

The results described were obtained based on the analysis of the ATDC support. In order to assess and determine the degree of appropriateness and sufficiency of ATDC to provide skills development support to small-scale aquaculture, a Likert scale was employed. This study utilised a 5-point ordinal Likert scale, where 1 indicated 'highly not appropriate or sufficient', and 5 represented 'highly appropriate or sufficient'. The results obtained were presented in a tabular form.

4.4.1 The appropriateness of ATDC

In terms of the appropriateness of ATDC in providing training and skills support to small-scale aquaculture, an examination of Table 4.7 reveals mixed perceptions regarding the appropriateness of ATDC for skills development in small-scale aquaculture.

a) Lack of awareness about the centre and its offerings

Notably, 33.4% of respondents were unaware of the centre's existence, hindering their ability to provide a rating. Additionally, the centre's limited reach and lack of awareness among potential participants forced them to incur high costs for private training. Therefore, ATDC requires increased marketing and promotion activities to increase awareness about the centre and its offerings.

b) Free training

Among those with knowledge of the ATDC, 27.8% considered it "fairly appropriate." They acknowledged the free fish farming skills training, but expressed an inability to utilise them, due to a lack of land and funding for starting their own farms.

c) Provision of limited courses

About 16.7% of respondents voiced strong criticism, deeming the ATDC "extremely inappropriate" for small-scale skills development. They highlighted the centre's focus on basic fish farming skills, neglecting crucial areas like farm management and financial literacy. Furthermore, the ATDC's training reportedly utilises species and culture systems uncommon among small-scale farmers, rendering the acquired skills inapplicable to their operations.

d) Accessibility and budget limitations

The results showed that 5.6% of respondents viewed the ATDC as "not appropriate" due to accessibility limitations. While the training is free, travel, accommodation and food costs create a barrier, especially considering South Africa's single ATDC location in Gariep, Free State, expected to serve and provide services to the entire country. Limited budgets to cover cost of transport to the centre, food and accommodation in the Gariep area does make the training prohibitively expensive for many rural farmers.

e) Lack of stringent selection criteria

However, a further 5.6% of respondents offered a positive perspective, finding the ATDC "highly appropriate" for skills development. The Centre's lack of stringent selection criteria, focusing on subsistence and small-scale operations, was seen as an advantage. This eliminates lengthy application processes and complex paperwork often associated with support programmes, making it easier for

small-scale farmers to access essential skills. Free training was also considered appropriate, especially for those already employed in aquaculture.

Table 4.7: The appropriateness of ATDC (n=18)

Rate the appropriateness of ATDC to provide training to small-scale aquaculture	Level of appropriateness	Frequency	Percentage
	Highly appropriate	1	5.6
	Fairly	5	27.8
	Appropriate	2	11.1
	Not appropriate	1	5.6
	Unknown	6	33.4
	Extremely inappropriate	3	16.7

Source: Data survey, 2023

4.4.2 The sufficiency of ATDC

In terms of the sufficiency of ATDC in providing training and skills support to small-scale aquaculture, as shown on Table 4.8, similar to the issue of appropriateness, awareness limitations hinder a complete picture of ATDC's sufficiency, as 33.4% of respondents were unfamiliar with the centre and could not provide their views.

a) Skills and research development

Among those who knew ATDC, 27.8% considered it "fairly sufficient", because it provided skills on fish farming at no cost, and the courses included practical hands-on training essential to run a fish farm. This is particularly valuable for small-scale farmers facing high private training costs. About 5.6% of respondent offered a positive view, finding the ATDC "highly sufficient" due to its training on breeding and culture techniques, research on fish species and nutrition, which are all critical aspects of fish farming.

b) Lack of comprehensive training

The results showed that 16.7% of respondents expressed strong dissent, deeming the ATDC "extremely insufficient." They criticised the centre’s focus on basic fish farming skills, neglecting crucial areas like farm or business management, financial literacy, and other technical specialties. There are a number of essential skills required by a farmer that are not covered by the centre. This concurs with

AgriSETA (2021) that in the case of small-scale farmers, there is a need for training in technical skills (water quality, nutrition and breeding) and management skills (supervisory skills and farm management), which are required for successful aquaculture operation. This necessitates reliance on expensive, comprehensive private training for successful farm operation. For this reason, these respondents indicated that they will still prefer a private training that provides comprehensive training that includes all required skills.

c) Limited range of species and culture systems.

South Africa only has one aquaculture demonstration centre, which is not sufficient to provide training for the whole country due to accessibility. Furthermore, the training focuses on a limited range of species and culture systems. This limits its applicability for small-scale farmers with diverse environments, temperatures, locations, market demands, and budgets. Consequently, the skills and training may not be directly applicable to their specific needs.

d) Lack of ongoing extension and technical support services

However, another respondent (5.6%) found it "insufficient" due to the limited number of courses and lack of ongoing extension and technical support services, which Rouhani and Britz (2004) identified as crucial for successful aquaculture operations.

Table 4.8: The sufficiency of ATDC (n=18)

	Level of sufficiency	Frequency	Percentage
Rate the sufficient of ATDC to provide training to small-scale aquaculture	Highly sufficient	1	5.6
	Fairly	5	27.8
	Sufficient	2	11.1
	Not sufficient	1	5.6
	Unknown	6	33.4
	Extremely insufficient	3	16.7

Source: Data survey, 2023

4.5 Results of benchmarking the support programmes for small-scale aquaculture farmers in South Africa against similar programmes in other countries

This section gives the results and a discussion of a comparison analysis between China, Egypt and South Africa, with the intention of reviewing the characteristics of the support programmes adopted by these countries to support small-scale aquaculture development. Table 4.9 shows this comparison,

focusing on crucial factors that reinforced the change towards a commercial sector in China and Egypt, in comparison with South Africa.

Table 4.9: Comparison analysis between China, Egypt and South Africa

Interventions	China	Egypt	South Africa
Legal and regulatory framework	Different ministries are involved in regulating aquaculture. However, the aquaculture authorising system is implemented according to the Fisheries Law, and authorisations to collectively own units to develop aquaculture and to utilise state-owned water resources may be granted by government agencies at or above the county level. The Bureau of Fisheries, which oversees aquaculture, falls under the Ministry of Agriculture, which is the primary managerial agency overseeing the aquaculture and fisheries sectors in China. The responsibilities include formulating policies, programmes and strategies, to develop fisheries and to implement and monitoring fisheries laws, and to regulate agreements, both international and bilateral. The Provincial, independent regions, municipalities and counties fisheries departments in China have similar responsibilities as the Bureau of Fisheries in their individual geographical locations.	Different ministries are involved in regulating aquaculture. In the case of Egypt, the government uses agencies for approvals of land and EIA. For example, land can only be leased from GAFRD for a period of five years. Fish producers must submit an EIA study to the Egyptian Environmental Affairs Agency (EEAA) for approval before they can apply for a licence. Creating general policies for land reclamation, agriculture (including aquaculture), and the development of rural economies are the responsibilities of the MoALR. Research and studies are also required in order to advance agriculture.	Different ministries are involved in regulating aquaculture. Various government departments on national, provincial and local levels have different directives that impact or can conceivably impact on the aquaculture industry in South Africa. The national government creates the institutional and legal framework for research and execution, frameworks and strategies, and policies for aquaculture. Currently, the Ministry of Environmental, Forestry and Fisheries plays a significant role as the lead department providing strategic management, regulating and creating sustainable aquaculture. However, each province has its own requirements and authorisation systems for freshwater aquaculture.
Policy framework	China developed policies in its effort to develop the sector. Hishamunda and Subasinghe (2003) showed that, while	Egypt did not have strong policies, as compared with China. The accelerated aquaculture development in the country took	In its efforts to develop aquaculture, South Africa has developed and implemented various programmes and policies. These

Interventions	China	Egypt	South Africa
	certain non-policy elements had a very small impact, government policies are mostly responsible for China's aquaculture development. Three policies were identified in the study that were intended to fast-track the development of the sector by enhancing the technologies being used, encouraging the usage of valuable species, and modifying the species mix based on market condition, easier to obtain licences, making resources available, such as land and water, and investing in high-quality seeds and feed, amongst other things. The policies are: - "Directive Notice on the Approval and Implementation of the Instruction of the Ministry of Agriculture to Further Expedite the Development of the Fishery Sector" (1997). - "The Instruction of Broaden Policies to Accelerating Fisheries Development" - "The Suggestion on Further Speeding Up Fisheries Development"	place in 1984-1997 and the policies identified were developed after this era. The Aquaculture Development Plan intended to develop inland fisheries in the identified suitable lakes through mega-national projects and the development of hatcheries. Because freshwater sources are scarce and there is competition with other sectors for water in the country, the policies in the country are focused on developing marine aquaculture and value-adding to meet the international standards. The policies identified included: - Fisheries and Aquaculture Policy - Economic and Social Development Plan Strategic Framework until 2022 - Water Resource Management Policy	policies facilitated the review of legislation and institutional arrangements governing aquaculture. The development of the financial incentive dedicated to aquaculture and the policy was intended to fast-track the development of the sector by removing the stumbling blocks. These policies included: - NASF, 2012. - NAPF, 2013. - Operation Phakisa – Oceans Economy (Aquaculture)
Extension services	China used a five-level aquaculture extension system to encourage and assist aquaculture farmers to apply improved farming methods and technology to optimise income and	Inadequate information is available on the aquaculture extension services in Egypt, while Rothuis and Van Duijn (2013) have indicated that extension services are not functioning, no specific budget is available for aquaculture,	As a new sector, the extension services in aquaculture are offered on a provincial level, but are very limited owing to lack of resources. For this reason, farmers face

Interventions	China	Egypt	South Africa
	maximise production. The extension services are offered at five levels, which are the national, provincial, city, county, and town levels. This makes it easier to reach and consult farmers. Various extension services are offered in the different levels, with national and provincial levels being responsible for extension plans and guidance, for testing of new technology or species, introduction and demonstration. Aquaculture extension staff and aquaculture farmers' technical training and skills development are organised by national and provincial levels. The county and town levels are responsible for administrative services, marketing services and technical services. The extension services in China have a wide range of responsibilities that are effective for the development.	and the connections between government, research and the aquaculture industry are weak. Through the publication of basic extension papers, the GAFRD extension and training directorates are responsible for disseminating information to farmers with lower levels of knowledge. GAFRD also organises and offers free aquaculture training courses (FAO, 2003). Furthermore, it organises events such as conferences, workshops and meetings for farmers.	challenges in obtaining ongoing technical support. The extension officers also lack appropriate skills. Despite being underfunded, AgriSETA (2021) stated that extension officers serve as the main point of contact for freshwater farmers. They do not always give farmers the right advice, and it can become complicated. And as a result of this, as well as failing to grasp fundamentals, farmers might become caught in a vicious cycle of low productivity, thereby achieving neither sustainability nor profitability.
Educational institutions	Elementary, secondary, specialised, higher, vocational, and adult education at various levels are all included in China's fishery education system. The Department of Freshwater Fisheries (mostly freshwater aquaculture) and the Department of Mariculture are located in the five fisheries universities/colleges. These institutions provide four years of instruction. For the purpose of the fieldwork, there are eight freshwater and marine culture farms totalling more than	There are numerous government research institutes and universities in Egypt that focus on fisheries education and research. The research conducted generally pays more attention to practical requirements intended at improving production efficiency.	The China-South Africa Agricultural Technology Demonstration Centre (ATDC) is a government aquaculture training centre. The primary focus of the Centre is on freshwater aquaculture training, demonstration, and research. The Centre also has a focus on the practice of fish breeding, assisting in terms of fish production shortfalls, farming of quality fish stock and remedying breeding difficulties. Therefore, the Centre responds to the shortage of

Interventions	China	Egypt	South Africa
	80 hectares of water. Fisheries (including aquaculture) comprise a specialty of higher education. Provincial and Municipal level middle fisheries specialist schools exist. Most of them have become experts in aquaculture and have formed the core of the front-line technical services for aquaculture in rural areas.		aquaculture skills and advisory services, identified as one of the major challenges. In addition to the Centre, AgriSETA (2021) notes that a number of universities and Agricultural Colleges in the country offer courses and/or modules on aquaculture.
Financial support	The Chinese government developed various mechanisms to provide financial support on a farm level. These included government loans through credit facilities to farmers and subsidies. The subsidies had a significant impact and raised the number of farms as well as production. The subsidies were provided through the Agriculture Supporting Fund to help aquaculture farmers to build fish ponds. Furthermore, they were used to promote species-specific production and investments in the sector. The Agricultural Bank of China and the Agricultural Financing Cooperation have been the primary sources of financing in recent years. In support of this , the National Agriculture Development Strategy served as the foundation for the government's creation of the credit policy.	Accessing loans from banks is difficult for aquaculture small-scale farmers in Egypt because the private and state-owned banks are hesitant to provide funding to aquaculture operations because of their lack of knowledge of the sector and they are not willing to conduct an appropriate risk valuation for aquaculture projects. Moreover, one of the key causes of financial inaccessibility for aquaculture is the perceived risk associated with aquaculture. Another problem is the collateral needed to obtain a loan, which is only approved when the customer's land ownership has been confirmed. However, the majority of SMEs in the aquaculture sector lease their land, rather than own it. Farmers primarily lease land from the government for a duration of three to five years. In order to stimulate investment within the sector, there are additional incentives like tax reductions and tax holidays, as well as exemptions on imported cages. However, these incentives appear to favour large-scale farmers over small-scale ones.	In 2013, the South African government introduced a cost-sharing incentive programme aimed at encouraging investments in the aquaculture industry, boosting output, expanding participation, and creating jobs. Red tape has prevented the incentive from reaching its goals. Due to a lack of finance, compliance issues and sustainability, small-scale farmers are not able to access grants of funding through ADEP. In addition to the ADEP, aquaculture operations can access grant funding through traditional agricultural grants such as CASP and MAFISA. However, there is still a lack of knowledge and expertise required to assess aquaculture projects. The DFIs and provincial DFIs can potentially fund the aquaculture operations through loans or equity. The DFIs have funded larger operations with track records and therefore are reluctant to fund small-scale aquaculture owing to the risks perceived.

Source: Hishamunda and Subasinghe (2003); Wang *et al.,* 2020; Zhiwen (1999); FAO (2003); Wally and Akingbe (2022); Goulding and Kamel (2013); Van Duijn (2013); Obwanga *et al*. (2018); DAFF (2012); DAFF (3013a); DTI (2013); Operation Phakisa (2014); AgriSETA (2021).

4.5.1 Financial support

4.5.1.1 Chinese financial support programmes

Financial support in the early stages of the development of aquaculture in China was provided in the form of subsidies and government loans. The subsidies were used to promote the production of certain species, stimulate investments, and increase production and the number of farms. The subsidies were provided through the Agriculture Supporting Fund in order to help aquaculture farmers build fish ponds, and the government also provided working funds. This shows that the government provided start-up capital to build and also assisted with working capital. Further to this, the Chinese government encouraged joint ventures or partnerships between the Central and Local Governments and gave grants and subsidies to private investors. It also developed a tax structure to divide the tax burden on investments between the Central and Local Governments. This subsidy assisted in stimulating investments and increasing production and the number of farms. The State also promoted species-specific production though subsidies, for example, to promote prawn production, the State provided financing for the first phase of construction of a one-hectare prawn culture pond.

The government in China also provided subsidised loans to support aquaculture farmers in growing production and improve their competitiveness through improving their facilities. It was also noted that organs of State, such as the provinces, municipalities and counties, were also involved in arranging subsidies.

4.5.1.2 Egyptian financial support programmes

The Egyptian government introduced incentives to boost the industry, such as exemptions from import duties on imported cages and tax holidays or breaks to attract investment. While it was noted that these measures primarily benefited large-scale farmers, they nonetheless contributed to the sector's development. Furthermore, the Egyptian government encouraged farmers to commercialise production by providing finance, according to Obwanga *et al.* (2018), which led to private sector investment in the aquaculture sector, particularly in the feed and fingerling industries.

4.5.1.3 South African financial support programmes

In South Africa, the ADEP was developed as a dedicated aquaculture incentive programme, with the main intention of stimulating investment in the aquaculture sector and increasing aquaculture production, employment, and geographical spread. As indicated earlier in this study, the grant is a cost-sharing reimbursable grant, requiring an applicant farmer to contribute a certain portion. This has been identified as a challenge, as many farmers cannot secure funding from commercial banks and DFIs. The DFFE (2019c) lists several government grant funding programmes, DFIs and commercial banks that could potentially provide funding support through grants, loans and equity. These funding mechanisms are, however, not specifically intended for aquaculture, and there is reluctance to consider aquaculture owing to perceived risks and a lack of understanding of the aquaculture sector.

Aquaculture, however, benefits from traditional agricultural grants, such as the Comprehensive Agricultural Support Programme (CASP) and the subsidised loans from the Micro Agricultural Financial Institutions of South Africa (MAFISA).

Small-scale aquaculture farmers in all three countries under study experience a common challenge in accessing credit from the banks, owing to reluctance based on the perceived degree of risk involved in aquaculture production and the requirement to provide collateral security. This shows that access to credit is not only a challenge to South Africa's small-scale aquaculture, but also to those sectors in other developing countries. However, the Chinese and Egyptian governments have put measures in place to ensure that their aquaculture sectors receive comprehensive and tailored-made financial support. South Africa still lags behind in terms of financial support for both the overall sector and small-scale aquaculture because it does not have a comprehensive financial tool that is tailor-made for aquaculture needs. Other funding mechanisms that aquaculture could potentially benefit from are not designed for aquaculture, but serve the needs of other sectors.

4.5.2 Extension services and educational institutions

4.5.2.1 Chinese skills development support programmes

China has a well-developed system for developing skills through extension services, and there are many distinct levels of fisheries education available in the country, including higher, secondary, elementary, specialised, vocational, and adult education, which demonstrates that early education is provided in Chinese aquaculture (Wang *et al.,* 2020). These measures were backed by a succession of policies and directives to encourage the development of a comprehensive, national aquaculture extension network.

In order to encourage and support aquaculture farmers in applying improved farming techniques to boost fish production and revenue creation, the Chinese government has further made significant efforts to develop technical training through enhanced extension programmes. The Chinese authorities developed and implemented a comprehensive extension system called five-level aquaculture extension, which consists of technical extension programmes, demonstration centres, and technical consultation, among other aquaculture extension models (Wang *et al.,* 2020). The extension services are categorised into jurisdictions, which are at the national, provincial, city, county, and town levels, and each category has responsibilities. The national and provincial levels are responsible for the introduction of key technologies, tested and demonstrated, and for technical training and skill development for aquaculture extension and disease management. The national extension plans and guidelines for developing the whole aquaculture extension system fall under their purview. The local aquaculture farms receive services from the city, county, and town-level extension schemes, including technical, marketing, and administrative services.

Institutions of higher learning, social groups, research centres, and aquatic businesses are all part of the five-level aquaculture extension design. China's research organisations that work with aquaculture are primarily concerned with carrying out government research assignments, developing and marketing innovative technology for aquaculture production, and suggesting extension initiatives to other government agencies. In China, universities also form a component of the extension system. These universities concentrate on training technology extension workers, creating new farming techniques as well as new breeding species, and offering government extension advice.

The extensive and high-quality extension services offered to farmers have been identified as a critical component in the development of aquaculture in China (Hishamunda & Subasinghe, 2003). It has also improved access to information and training, as well as production capacity. It is clear that China offers a comprehensive extension support system, which offers a wide range of services, such as skills development (technical and management), the introduction, testing and demonstration of key technologies and new breeding species, and rendering extension advisory services that assist farmers in applying improved farming methods in order to increase their fish production and income generation.

4.5.2.2 Egyptian skills development support programmes

The Egyptian Ministry of Agriculture and Land Reclamation's subsidiary organisation, GAFRD, is in charge of extension and support operations throughout Egypt. Every major GAFRD branch contains an extension centre with a pilot farm, hatchery, and labs for soil and water study (FAO, 2003). These centres provide free services, upon request. Moreover, private farmers are offered fish seed produced in these government hatcheries or gathered by its fry collection stations at a lower cost. Furthermore, numerous government research institutes and universities exist that specialise in fisheries education and research. Participation in research activities on-farm is also available through government-run facilities. Simple extension papers are published by the GAFRD extension and training directorates, who are in charge of informing farmers. GAFRD also plans and conducts free aquaculture training programmes. It is clear that Egypt does not offer as comprehensive skills development as China does; however, the country has succeeded in transferring skills and technologies to farmers. This can be attributable to the easy access of farmers to extension and demonstration centres, which are available at each branch.

4.5.2.3 South African skills development support programmes

According to AgriSETA (2021), there is little extension support available (specialised state extension officers, veterinarians, and researchers), and only a tiny pool of skills and expertise, in South Africa's aquaculture industry. Aquaculture farming, as a profession and educational path, is not well known. The Aquaculture Technology Demonstration Centre (ATDC) was developed so as to provide training and the promotion and demonstration of breeding and culture techniques, as well as conduct research activities on growth patterns and related nutrition options for various freshwater fish. However, it is clear from the literature and data collected that the skills development available through the ATDC is not

comprehensive. There are a number of essential skills required by a farmer that are not covered by the centre.

Extension services are offered on a provincial level, and not on a local or branch level as in China and Egypt. This proves to be a challenge, since the small-scale farmers are widely dispersed and there is a limited number of extension officers, making access to ongoing advisory services difficult to obtain. There are also a number of universities and colleges in South Africa that offer aquaculture courses or aquaculture as a module/subject. It is clear that, unlike China, where aquaculture is provided in early education, South African aquaculture education is only offered at the tertiary level. Appendix 3 shows these educational institutions and their offerings. In terms of skills development and technical support, it is clear that South Africa is still lagging behind both China and Egypt. This is attributable to the fact that South Africa does not provide comprehensive aquaculture skills development and technical support for local aquaculture needs, as a business.

4.5.3 Synthesis of benchmarking results:

This section analyses the financial support and skills development programmes for small-scale aquaculture in South Africa as compared to China and Egypt.

In terms of financial support, South Africa relies on a single programme, ADEP, that offers cost-sharing reimbursements, creating a barrier for farmers lacking upfront capital. Additionally, existing government grants and loans are not specifically designed for aquaculture, leading to reluctance from lenders due to perceived risk. Both China and Egypt as benchmarks countries offer more comprehensive financial support. China provides subsidies, government loans, and tax breaks specifically for aquaculture, while Egypt uses exemptions from import duties and tax holidays to attract investment. These measures directly address the challenge of high upfront costs and competitiveness, and encourage private sector involvement.

With regards to skills development and extension services, South Africa has a limited extension service network compared to China and Egypt. The only demonstration centre, ATDC, offers some training, but lacks comprehensiveness, and struggles to reach geographically dispersed small-scale farmers. Additionally, aquaculture education is only available at tertiary level, unlike China's approach, which integrates it into early education. In terms of benchmarking, China has a well-developed, multi-level extension system with national, provincial, and local levels offering technical training, demonstration centres, and technical consultation. Egypt, while not as comprehensive as China, provides easier access to extension services, through branch-level centres with pilot farms and hatcheries. Both countries offer more readily available training and technical support to farmers.

Overall**,** it is clear that South Africa lags behind both China and Egypt in both financial support and skills development for small-scale aquaculture. The lack of comprehensive, tailor-made financial tools and a

limited extension service network hinder the growth of the sector. Benchmarking the successful strategies of China and Egypt, such as subsidies, tax breaks, and a multi-level extension system, could significantly improve the support system for small-scale aquaculture farmers in South Africa.

4.6 Summary

This chapter has interpreted and discussed the results obtained through primary data collection derived from a survey conducted among aquaculture farmers in Gauteng and the three government departments implementing the government programmes, ADEP and ATDC. In addition, the results of a comparative analysis between the two successful large aquaculture countries, China and Egypt, with South Africa. The results show that in terms of the demographics of small-scale aquaculture in Gauteng, most farms are owned by males between the ages of 46 to 56 years and above. A majority of farms have a secondary source of income, such as vegetable farming, aquaculture training and system designs and construction. Most of the small-scale farmers under study knew about the ADEP and had applied for financial support but had been declined. The results further showed that the ADEP is not appropriate and sufficient for small-scale development, as it does not address small-scale financial needs. The programme does not offer comprehensive financial support and requires contributions from farmers for accessing grant funding.

In terms of skills development, the results showed that the ATDC is neither appropriate nor sufficient for small-scale aquaculture. Although attaining aquaculture training and other services through the ATDC is free and easier to achieve, owing to the absence of qualifying criteria, the ATDC does not offer comprehensive training and skills development, but rather offers basic fish farming courses. This excludes vital courses in human and financial management, which are required for a successful operation.

The results of a comparison between China and Egypt with South Africa showed that, in terms of the financial support programmes in the other countries, China used different types of funding mechanisms for different objectives. It provided subsidies to build farms, as well as for working capital. Moreover, government loans and subsidies were given in order to increase competitiveness and breeding production. In a similar vein, Egypt has provided incentives to grow the industry, such as tax holidays and cuts on the import duties for cages, as well as waivers of other taxes. Additionally, Egypt encouraged farmers to start businesses by providing incentives, which led to private sector investment in the aquaculture industry, particularly in the feed and fingerling sectors. In addition, incentives have stimulated farmers to commercialise production through funding.

In terms of benchmarking the skills development programmes in other countries, the results of the comparison between China and Egypt with South Africa showed that China used a five-level extension system, which provided comprehensive extension services that included demonstration centres, advisory services, and training. The extension services offer quality education to farmers that cover all

aspects of a fish farm operation, including marketing and financial management. Egypt has also successfully transferred new technology to its farmers through extension services, with the GARD offering demonstration centres and providing extension advisory and other services to farmers at a branch level, thereby making access to services and information easier to obtain.

CHAPTER 5:

SUMMARY, CONCLUSIONS & RECOMMENDATIONS

This Chapter outlines a summary of the dissertation. It revisits the problem statements and objectives of the study, and summarises the main findings obtained in relation to the intended objectives. The chapter illustrates whether the objectives of this study were reached, thereby achieving the main objective of determining the appropriateness and sufficiency of the public support provided to small-scale aquaculture producers in Gauteng Province, in South Africa. The chapter further generates conclusions derived from the research findings. Possible actions and solutions will be listed as recommendations under this chapter.

5.1 SUMMARY

This study was conducted in Gauteng Province, South Africa. The main objective of the study was to assess the appropriateness and sufficiency of public support for small-scale aquaculture producers in the selected study area. The specific objectives of the study were to:

5.1.1. identify the challenges faced by small-scale aquaculture farmers;

5.1.2. determine whether the financial support provided through the Aquaculture Development and Enhancement Programme (ADEP) is sufficient and appropriate for small-scale aquaculture;

5.1.3. investigate whether the skills development support services provided through the Aquaculture Technology Demonstration Centre (ATDC) is sufficient and appropriate for small-scale aquaculture; and

5.1.4. benchmark the support programmes for small-scale aquaculture farmers in South Africa against similar programmes in other countries.

The results showed that small-scale aquaculture is male-dominated, and that the owners were older adults, aged between 36 and 55+ years, with the sector attracting less interest from the younger population. Their fish farming activities were typically integrated with other business activities as a secondary source of income to supplement the fish farm component. This was done because fish takes time to reach market size and render the operation profitable. The findings regarding the objective of identifying challenges faced by small-scale aquaculture farmers indicate that gaining access to funding remains the major challenge to the development of small-scale aquaculture. The majority (89%) of the farmers in the study could not access funding because of a lack of land and the reluctance of credit providers to fund aquaculture. An amount between R1 and R5 million in capital was required to build a small-scale farm, and further funds were required for working capital to pay for seed, feed, and labour, among other things. Regulatory barriers, as well as lacking skills/aquaculture expertise, were rated as comprising one of the major contributors to the underdevelopment of the industry. Having relevant skills/aquaculture expertise for both aspiring small-scale farmers and extension officers is essential for

a successful sector. The quantity and quality of the available extension services is in sufficient to equip and produce profitable, successful farmers. It was found that there were no extension officers in the areas where these farmers operated. A lack of access to land or sea space, lack of markets, competition with Chinese cheap fish imports, and the higher capital required to start a farm were also identified as being larger contributors. The energy crisis faced by the country was found to impact small-scale aquaculture negatively, which led to higher operational costs attributable to the use of generators, and in a worst-case scenario, would result in farm closure. The findings indicated that small-scale farmers face similar overheads as that of commercial farms, although small-scale farmers are unable to expand their operations to larger operations, due to the overwhelmingly complex regulatory environment.

The ADEP is well known in the sector and a large number of small-scale farmers have applied to the programme to get financial assistance. The findings revealed that the ADEP application criteria and minimum eligibility requirements were highly unlikely to be satisfied by small-scale aquaculture farmers. The higher rate of refusal was attributable to the lack of access to finance and regulatory barriers, as well as the uncertain viability of the small-scale farms, among other contributing factors. A significant number of respondents indicated that the impact of the programme proves very poor for the development of small-scale aquaculture. The findings on this objective indicated that the ADEP is highly inappropriate or relevant to the development of small-scale aquaculture, because it does not address the financial needs of small-scale farmers. Furthermore, its offering was highly insufficient in terms of financial support, as it does not provide start-up capital and requires farmers to secure their own capital before they access the grant. The programme does not provide start-up capital, and it requires farmers to provide their own contribution, as well as having land in order to access the grant. This has proved to be a challenge for small-scale aquaculture farmers.

The ATDC has a simple procedure for accepting requests for training and technical support, although a challenge was identified with regard to this centre, in the sense that it is not well known by the small-scale farmers under study. Its location, transport and accommodation costs play a significant role in rendering small-scale aquaculture incapable of accessing the training. Furthermore, the centre provides basic fish farming courses. Small-scale farmers not only require one set of skills to effectively manage their farms and become fully productive, but also require sets of various skills, such as technical skills, personal skills, and management skills. The ATDC does not provide such courses, including business management-related courses that are essential for a successful and sustainable farm. Comprehensive skills development and training are required for the profitable and effective management of a farm. The findings indicate that ATDC training is highly inappropriate for aquaculture skills development, as it does not address the farmers' needs for skills and technical expertise. The centre's limited reach and lack of awareness among potential participants force them to incur high costs for private training. Therefore, ATDC requires increased marketing and promotion activities to increase awareness about the centre and its offerings. The training focuses on a limited range of species and culture systems. This limits its applicability for small-scale farmers with diverse environments, temperatures, locations, market demands, and budgets. Consequently, the skills and training may not be directly applicable to their

specific needs. ATDC was found to be highly insufficient for small-scale skills development, as it offers only basic fish farming courses, whereas operating a profitable farm requires a set of skills that include management and personal skills. In addition, lack of ongoing extension and technical support services offered by the Centre.

The results of the comparison analysis between China, Egypt with South Africa indicated that there are a number of different ministries involved in regulating aquaculture. Therefore, similar to South Africa, these two counties require authorisations to be obtained from various different departments. However, China has managed to simplify this process by offering licencing and permits at the town level, which could reduce the time taken to obtain an authorisation. The difference identified was that aquaculture in both China and Egypt was managed under the Ministry of Agriculture, while in South Africa, it is managed under the Ministry of Environmental, Forestry and Fisheries.

Financial support in the early development of aquaculture in China was provided in the form of subsidies. The subsidies were used to promote the production of certain species, stimulate investments, and increase production and the number of farms. In Egypt, the government implemented incentives to develop the sector, including waivers on imported cages, and tax breaks/tax holidays to encourage investment in the sector. In South Africa, the ADEP was developed as a dedicated aquaculture incentive, with the main intention to stimulate investment in the aquaculture sector, and to increase aquaculture production, employment and geographical spread. However, the programme does not address the financial needs of the small-scale aquaculture farmers. The Chinese and Egyptian governments have put measures in place to ensure that their sectors receive comprehensive and tailored-made financial support. South Africa still lags behind in terms of financial support for both the overall sector and the small-scale aquaculture sub-sector, because it does not have a comprehensive financial tool that is tailor-made for aquaculture needs. Other funding mechanisms that aquaculture could potentially benefit from are not designed for aquaculture, but for other sector's needs and requirements.

Chinese extension services are well developed, and fisheries education in China includes higher, secondary, elementary, specialised, vocational and adult education, at many different levels. Egypt has also successfully transferred new technology to its farmers through extension services, with the GARD offering demonstration centres and providing extension advisory and other services to farmers at a branch level, making access to services and information easier to obtain. The Chinese government has used the five-level aquaculture extension system to encourage and assist aquaculture farmers to apply improved farming methods and technology in order to increase their fish production and income generation. The extension services are offered at five levels, viz. the national, provincial, city, county, and town levels, which makes it easier to reach and consult farmers. The aquaculture sector in South Africa has a small pool of skills and knowledge available, and there is limited extension support provided. Furthermore, only one demonstration centre is available and its location makes it difficult for farmers to attend to obtain skills development and training. South Africa is still lagging behind, when

compare with China and Egypt in terms of skills development and technical support. This is because South Africa does not have comprehensive aquaculture skills development and technical support in place for local aquaculture needs as a business operation.

In addition to the above-mentioned characteristics of support offered in China and Egypt, the two countries have strong policies in place to promote the development of aquaculture, especially China. These policies were strong in advancing technology, introducing new viable species, providing a conducive regulatory environment for farmers and incentives for small-scale farmers. Similar policies have been developed in South Africa, in endeavours to grow the sector, for example Operation Phakisa. However, the implementation of these policies has not been sufficient.

5.2 CONCLUSION

The study results show that small-scale aquaculture remains underdeveloped, and continues to face various challenges that limit its potential and development. The lack of funding, regulatory barriers and lack of skills are still major challenges. However, the lack of access to land/sea space and to markets, energy crises and the lack of proven production systems were identified as hindrances to the development of the sector. The government interventions to address these challenges have had little impact on the development of small-scale aquaculture, and are therefore highly not appropriate and are highly insufficient. Both the programmes that were investigated in this study, namely the ADEP and the ATDC, are important for the sector, but have proven to be insufficient and inappropriate in providing the financial and skills development required for small-scale aquaculture development.

The case of China shows that aquaculture sector development in China was largely attributable to government policies and support. However, in the case of Egypt, fewer records of such support were found, which may indicate that the development of aquaculture not only depends on government support, but also on other external factors that do contribute. Moreover, Soliman and Yacout (2016) have confirmed that the major increase in the usage of new technology, water circulation systems, extruded feedstuffs and enhanced farm management methods are primarily responsible for the increase in aquaculture productivity. The industry has become increasingly sophisticated and varied as a result of the rapid growth of auxiliary support businesses, including domestic feed mills and hatcheries.

Although a number of small-scale farmers have lost hope in the South African government and its potential to provide an efficacious support programme, the study shows that there are possibilities and potential for improving the existing support programmes to become more appropriate and ultimately sufficient for small-scale aquaculture needs, as well as for achieving government goals.

5.3 RECOMMENDATIONS

This section provides various interventions and recommendations for addressing the current challenges to fish farming.

5.3.1 Aquaculture blended financial model

The Chinese government, in the early development of aquaculture, provided subsidies to build a farm, provided working capital funding, and in addition, provided a subsidised credit facility for farm expansion and increasing competitiveness. To benchmark this, a blended funding model is recommended for the ADEP, which ought to be appropriate and sufficient for providing financial support for small-scale aquaculture farming. It is recommended that the ADEP be reviewed and blended with seed funding (start-up capital), which can be offered as a pure grant together with a subsidised loan that offers a low-interest loan for own contribution, working capital and for improving the competitiveness of the farm.

Given the nature of aquaculture operations, where it takes time for the farmers to sell their first produce/batch, since fish take time to reach market size, a moratorium linked to the growth period/life cycle of fish could be provided. In simple terms, a moratorium is defined as a delayed or short-term suspension of payment granted owing to a crisis that causes financial pressure (CFI, 2022). Accordingly, a farmer would be allowed a period during which repayments of the loan are suspended, until such time that that they are reasonably able to do so. This would address the major challenges associated with the poor impact of ADEP on small-scale aquaculture, such as limited access to funding, complex regulatory barriers and requirements for viability.

ADEP is currently being implemented by the DTIC. According to the Public Finance Management Act (PFMA) the government departments are discouraged from offering loans as it falls outside their responsibilities. In addition to this, the National Credit Act (NCA) regulates the credit industry in South Africa, including lenders and borrowers. Government departments would not be licensed under NCA to offer loans to the public. For these reasons, the DTIC would not be able to provide a soft or subsidised loan as part of the Aquaculture blended financial model.

It is recommended that the Land and Agriculture Bank of South Africa (“Land Bank”) as a specialised agricultural Development Finance Institution that provides financial services and products to the agricultural sector (Land Bank, 2024), be blended with ADEP or be part of the Aquaculture blended financial model. This will allow co-financing aquaculture transactions between the DTIC and Land Bank as an accredited DFI to provide subsidised aquaculture loans.

5.3.2 Comprehensive aquaculture extension system

Egypt provides extension services at a branch level and has demonstration centres in each branch. China uses a five-level extension system, which provides comprehensive extension services at the national, provincial, municipal and town levels. In both Egypt and China, access to extension services is easily accessible by farmers, and in addition, the services and information provided are of quality and relevant for improving farming. Owing to the size and geographical spread of the small-scale farmers in South Africa, it may prove challenging to benchmark similar models used by China and Egypt. Similar to other African countries, extension agents have to contact many dispersed small-scale producers, which makes their work difficult due to a lack of staff and funding, as well as the geographical dispersal of farmers (Sen, 1996). Because of this, small-scale producers struggle to obtain information, especially about markets, and have little technical experience (Brugère & Ridler, 2004). However, in order to increase the appropriateness and sufficiency of the ATDC services for the skills development of small-scale farmers, it is highly recommended that further aquaculture demonstration centres be built in each province, thereby addressing the issue of proximity and costs associated with travelling to a centre, which has prohibited greater numbers of small-scale and aspiring farmers from attending for training and obtaining other relevant services. The centres should add business, personal and management-related courses, which are essential for effective management of a farm, especially financial management, record keeping and other personal skills. The government should also invest in increasing the number of quality aquaculture extension officers and their expertise or skills in aquaculture. The findings also indicated that the ATDC is not well known by the small-scale aquaculture farmers, and it is therefore recommended that the demonstration centre ought to increase its promotion and awareness activities. Proper guidelines as to what they offer should be developed, and then implemented.

Among other difficulties revealed by Jiang *et al*. (2016), was the fact that farmers lacked access to the technologies utilised at the centre. As a result, the methods learnt at the ATDC could not be used at their own aquaculture facilities. Therefore, the Centre should add improved systems that are commonly used by small-scale farmers to allow them the opportunity to choose from a variety of systems they are able to operate, and can afford.

It is recommended that the DFFE in collaboration with the provincial Department of Agriculture in each province implement the comprehensive aquaculture extension system. Higher learning institutions such as universities and colleges will also play a critical role in this system by providing aquaculture courses to both extension officers and farmers.

5.3.3 Aquaculture small-scale development policy

The cases of China and Egypt prove that their governments, through policy instruments, supported the development of aquaculture in their countries. In China, particularly, the aquaculture development achieved was entirely an outcome of government policies, although some non-policy factors played a

very small role. The lesson learned from the benchmarking of the Chinese aquaculture sector is that the government's policies showed the commitment of the government to grow the sector. The policies promoted new technologies, high-value species, where the production of new species was incentivised. Resources such as land and water were made available and were prioritised for aquaculture use.

South Africa should develop a policy dedicated to the development of small-scale aquaculture. This policy should address, over and above access to finance and skills development, other issues, such as cheap fish imports, regulatory barriers, technology use, alternative energy sources, and research and development. As the study findings have indicated, cheap fish imports contribute to the underdevelopment of small-scale aquaculture, and accordingly, the government should prioritise protectionism against foreign fish imports to protect small-scale farmers against competition. Another recommendation regarding imports is that the government could subsidise aquaculture inputs, such as feed, seed and chemicals, which contribute to higher production costs. By doing this, small-scale aquaculture would be able to reduce their prices and compete with cheap imported fish.

The sector is highly regulated, and policies that promote reducing and simplifying regulations for small-scale aquaculture would allow new entrants, and would promote development in the sector. Sectors such as tourism have developed grant funding that is dedicated to assisting SMEs in their sector to install energy- and water-efficient resources (Department of Tourism, 2021). This funding mechanism assists businesses to install alternative energy sources, such as renewable energy generating systems (solar and wind solar), thereby enabling business continuity during electricity loadshedding. These systems further assist businesses in reducing operational costs. A similar funding mechanism could be adopted to assist small-scale aquaculture farmers in dealing with loadshedding.

As a custodian of aquaculture in the country, it is recommended that the DFFE develop and implement the aquaculture small-scale development policy. Although other key stakeholders will play a vital role in the implementation of the policy, the DFFE will coordinate and oversee the overall implementation.

5.3.4 Comprehensive aquaculture research and development

The study results indicated that failed aquaculture production systems comprise one of the major stumbling blocks for small-scale aquaculture development in South Africa. It showed that a number of small-scale farmers had been unsuccessful, because they were victims of expensive production systems that ultimately failed. The literature shows that, in addition to the ATDC, aquaculture has other role players, such as the DST and ARC, which undertake research and technology dissemination, respectively, as well as universities and the SABS, which ensures standardisation and the quality of processes, goods and services. These institutions ought to work more closely together with the government to ensure that small-scale aquaculture is protected against proven, failed production systems and species. Further research and development should be undertaken in improving and

introducing technology, species and feed that are of high quality, suitable for South African conditions, and would improve productivity and income.

5.4 Limitation of the study

There were problems encountered during the conduct of this study that were noted as being limitations. According to Price and Murnan (2004), a research study's limits are those aspects of its design or technique that have an impact on how its findings are understood. Furthermore, limitations refer to the constraints imposed on the capacity to extrapolate from the results obtained, stemming from the study design that was chosen, the procedures employed to ensure the study's internal and external validity, or unforeseen difficulties that arise during the investigation (Brutus *et al.,* 2013) or the outcome of unanticipated issues that occur when the study is conducted (Price & Murnan, 2004). For the study to be conducted and completed with the available resources, finance and time, the following limitations were identified, as described below.

5.4.1 Lack of previous research on the topic

The lack of previous research studies on the topic limits the study, to a certain degree, as prior research studies could have formed the basis of a literature review, and also assisted to understand the research problem investigated. Little prior research is available on the status, challenges and possible solutions, and the lack of appropriateness and sufficiency of an intervention in South African aquaculture.

5.4.2 Sample size

This study paid specific attention to small-scale aquaculture, and the collection of data was restricted to this producer category, as confined within Gauteng Province. Only 55% of farmers responded to the study questionnaire. This means that only 18 out of a sample of 33 farmers actually responded to the questionnaire. This came after lengthy and many attempts made to obtain responses. Approximately 25% of the farmers indicated that they were not interested in participating, 10% never responded or said they were either sick or committed elsewhere, 5% replied that they were no longer operating in aquaculture, and 5% indicated that they were mistakenly listed as aquaculture farmers on the internet. A snowballing method was then followed by requesting referrals about other relevant farmers from the farmers who were willing to participate.

5.4.3 Resources

Resources, such as funding, capacity and available time, limited the data collection methods to be used, as well as the sample size. Because the sector is very small and farms are dispersed across the country, the data collection was limited to using questionnaires and telephone interviews. This made it very hard

to collect sufficient primary data in a timeous manner. Delays in obtaining responses from farmers also delayed the process, and the data collection process had to be extended by additional months.

5.5 RECOMMENDATIONS FOR FUTURE RESEARCH

There are a number of issues and research gaps that emanated from this study, which would require future studies to be done.

The appropriateness and sufficiency of public support to aquaculture producers across South Africa is the primary field for future research, as the current study focused on small-scale farmers based in Gauteng Province, and was limited to two government programmes, the ADEP and ATDC. Further research studies could be undertaken, focusing on the overall sector, and investigating the appropriateness and sufficiency of a wider range of aquaculture public support programmes.

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APPENDIX 1: Aquaculture small-scale questionnaire

Dear participant

My name is Masuping Mofokeng. I am currently registered for Master`s Degree in Agriculture (Rural Development) with the University of Pretoria. I am undertaking a research project titled: "The appropriateness and sufficiency of public support to small-scale aquaculture producers in Gauteng Province, South Africa." The main objective of the study is to assess the appropriateness and sufficiency of public support to small-scale aquaculture producers in South Africa. The study further looks at the following specific objectives:

1. investigate the challenges faced by small-scale aquaculture farmers;
2. determine whether the financial support available through the Aquaculture Development and Enhancement Programme (ADEP) is sufficient and appropriate for small-scale aquaculture;
3. investigate whether the skills development support services available through the Aquaculture Technology Demonstration Centre (ATDC) are sufficient and appropriate for small-scale aquaculture; and
4. benchmark the public support programmes for small-scale aquaculture farmers in South Africa against similar programmes in other countries.

The results obtained are expected to assist government and aquaculture stakeholders to determine whether the current policies and support programmes are appropriate and sufficient or there are other external factors that needs to be considered in order to develop the small-scale farmers. The study findings and recommendations will also assist in informing appropriate interventions when formulating development policies and support programmes for small scale aquaculture.

I hereby kindly requesting you to fill in and complete the questionnaire. The questionnaire will only take less than 20 minutes of your time. Kindly note that your participation in this survey is voluntary and you free to not answer the questions you not comfortable with.

Information provided in this questionnaire is confidential, your name and or entity will not be connected to your answers. Only collective data will be used in the report. I hereby certify that this is an honest interview taken in accordance with my academic needs only.

If you have further questions and comments, please contact my supervisor, Prof. Charles Machethe, at charles.machethe@up.ac.za

Thank you for your participation, time and consideration.

Yours sincerely,
Masuping Mofokeng (Student Researcher)

1. Demography Questions

1.1. Name of the Farm

……

1.2. Place and Province the farm is operating

……

1.3. Owners Gender

Male		Female	

1.4. Age range

18-25		26-35		36-45		46-55		56+	

1.5. Race

Black		Colored		Indian		White	

1.6. Highest qualification obtained

Matric		Diploma		Degree		Post Grad. Qualifications		None	

1.7. Aquaculture Skills/ Training Level (Do you have any experience/ training in aquaculture prior starting the farm?)

No skills in aquaculture		1-2 years' work experience		3-5 years' work experience		5+ years' work experience		Formal aquaculture training	

1.8. What was your experience obtaining aquaculture training/skills?

……

2. Farm Operations Questions

2.1. Type of fish species farmed

……

2.2. Culture system/ technology used:

……

2.3. Total Quantity per annum/ year:

……

2.4. Market products are sold to:

Local market		Export market		Mixed	

2.5. Type of market

Formal market		Informal market		Mixed	

2.6. How do you sell your products?

Whole		Gutted		Processed		Others	

2.7. On scale of 1-5, how will you rate the availability of market or acceptance of aquaculture product.

5	Excellent	
4	Good	
3	Fair	
2	Poor	
1	Very poor	

2.8. Average prices

Price (ZAR)	5-10	15-25	26-35	36-45	46-55	56-65	66-75	76-90	90+
Quantity (per fish									

or per kg)									

2.9. How is the farm financed?

Own Funds		Loans		Government Grants	

2.10. What was the initial amount/ capital investment to develop the farm?

R10,000-R100,000		R110,000-R1m		R1,2m-R5m		R5,1m-R10m		R10m+	

2.11. How was your experience securing funding?

……

2.12. How many people employed on the farm?

……

2.13. What are the challenges you face as a small-scale aquaculture farmer?

……

3. To determine whether the financial support through the Aquaculture Development and Enhancement Programme (ADEP) is sufficient and appropriate to small scale aquaculture.

3.1. Do you know about ADEP? If Yes, how did you know about it?

……

3.2. Have you benefited on the Aquaculture Development and Enhancement Programme (ADEP)?

……

3.3. If No, why?

……

……

……

3.4. If yes, how did the grant benefit the development of your farm? ……
……

3.5. On scale of 1-5, how will you rate the appropriateness of the programme to provide financial support to small-scale aquaculture?

		Answers
5	Highly appropriate	
4	Appropriate	
3	Fair	
2	Not appropriate	
1	Highly not appropriate	

3.6. On scale of 1-5, how will you rate the sufficiency of the programme to provide financial support to small-scale aquaculture?

		Answers
5	Highly sufficient	
4	Sufficient	
3	Fair	
2	Not sufficient	
1	Highly not sufficient	

3.7. What would you suggest to improve the effectiveness of the ADEP programme?

……
……

4. To investigate whether the skills development support services through the Aquaculture Technology Demonstration Centre (ATDC) is sufficient and appropriate to small scale aquaculture.

4.1. Do you know about ATDC? If Yes, how did you know about it?

……

4.2. Did you participate in the design and planning of the support programme?

……

4.3. Have you benefited to any training offered by the China-South Africa Aquaculture Demonstration Centre?

……

4.4. If No, why?

……

……

……

4.5. If yes, how did the training/ demonstrations benefit you and the development of your farm?

……

……

4.6. On scale of 1-5, how will you rate the appropriateness of the programme to provide financial support to small-scale aquaculture?

		Answers
5	Highly appropriate	
4	Appropriate	
3	Fair	
2	Not appropriate	
1	Highly not appropriate	

4.7. On scale of 1-5, how will you rate the sufficiency of the programme to provide financial support to small-scale aquaculture?

		Answers
5	Highly sufficient	
4	Sufficient	
3	Fair	
2	Not sufficient	
1	Highly not sufficient	

4.8. Does government provide continues training in your area, do you need such training?

……

4.9. Any suggestion on how to improve the effectiveness of ATDC?

……

……

4.10. Do you have knowledge of any government support towards small scale aquaculture not mentioned above? If yes, please mention them.

……
……

4.11. Have you benefited to any of this government support? If yes, how?

……
……

4.12. Which major challenges have you encountered from starting your farm until now and how did you deal with them?

……
……

4.13. In your own opinion, what will you say is the main challenges towards small scale aquaculture development?

……
……
……

4.14. Any suggestions/ comments

APPENDIX 2: Support Programme Questionnaire

Dear participant

My name is Masuping Mofokeng. I am currently registered for Master`s Degree in Agriculture (Rural Development) with the University of Pretoria. I am undertaking a research project titled: "The appropriateness and sufficiency of public support to small-scale aquaculture producers in South Africa." The main objective of the study is to assess the appropriateness and sufficiency of public support to small-scale aquaculture producers in South Africa. The study further looks at the following specific objectives:

5. investigate the challenges faced by small-scale aquaculture farmers;
6. determine whether the financial support available through the Aquaculture Development and Enhancement Programme (ADEP) is sufficient and appropriate for small-scale aquaculture;
7. investigate whether the skills development support services available through the Aquaculture Technology Demonstration Centre (ATDC) are sufficient and appropriate for small-scale aquaculture; and
8. benchmark the public support programmes for small-scale aquaculture farmers in South Africa against similar programmes in other countries.

The results obtained are expected to assist government and aquaculture stakeholders to determine whether the current policies and support programmes are appropriate and sufficient or there are other external factors that needs to be considered in order to develop the small-scale aquaculture. The study findings and recommendations will also assist in informing appropriate interventions when formulating development policies and support programmes for small scale aquaculture.

I hereby kindly requesting you to fill in and complete the questionnaire. The questionnaire will only take less than 20 minutes of your time. Kindly note that your participation in this survey is voluntary and you free to not answer the questions you not comfortable with.

Information provided in this questionnaire is confidential, your name and or entity will not be connected to your answers. Only collective data will be used in the report. I hereby certify that this is an honest interview taken in accordance with my academic needs only.

If you have further questions and comments, please contact my supervisor, Prof. Charles Machethe, at charles.machethe@up.ac.za

Thank you for your participation, time and consideration.

Yours sincerely,
Masuping Mofokeng
Student Researcher

1. **Data on the Support Programme**

1.1. The objectives of the programme

……

……

……

……

1.2. The targets of the programme

……

……

……

1.3. Eligibility Criteria for the programme

……

……

……

……

1.4. On scale of 1-5, how will you rate the eligibility criteria being achieved by the small-scale aquaculture?

		Answer
5	Highly likely	
4	likely	
3	Fair	
2	unlikely	
1	Highly unlikely	

……

1.5. What is the most challenging requirement to be achieved by small-scale aquaculture?

……

……

1.6. In your own opinion are these requirements achievable by small scale farmers?

……

……

1.7. How is the programme marketed and is the information on the programme accessible to small-scale farmer?

……

……

……

2. Information on small scale farmers?

2.1. On average how many small-scale aquaculture farmers apply for the support annually?

……

2.2. On average how many commercial aquaculture farmers apply for the support annually?

……..

2.3. The average number of small-scale farmers benefited from the programme annually?

……

2.4. The average number of commercial farmers benefited from the programme annually?

……

2.5. The average number of small-scale farmers declined?

……

2.6. What was the main reason for declining/ withdrawal?

……

……

……

2.7. The average number of commercial aquaculture farmers declined?

……

2.8. What was the main reason for declining/ withdrawal?

……

……

……

2.9. On scale of 1-5, how will you rate the impact of the programme on the development of overall aquaculture sector in South Africa?

		Answer
5	Excellent	
4	Good	
3	Fair	
2	Poor	
1	Very poor	

2.10. On scale of 1-5, how will you rate the impact of the programme on the development of small-scale aquaculture?

		Answer
5	Excellent	
4	Good	
3	Fair	
2	Poor	
1	Very poor	

2.11. What are the main challenges in relation to support the small-scale farmers?

……

……

……

2.12. On scale of 1-5, how will you rate the impact of the programme on the development of commercial aquaculture?

		Answer
5	Excellent	
4	Good	
3	Fair	
2	Poor	
1	Very poor	

2.13. What are the main challenges in relation to support the commercial farmers?

……

……

……

2.14. In your own opinion what are the major interventions required to develop small scale aquaculture in South Africa?

……

……

……

2.15. Other comments

……

……

……

……

APPENDIX 3: Educational institutions and their aquaculture offerings in South Africa

Institution	Type	Offering
University of Cape Town, WC	University	Departments of Botany and Zoology provide a post-graduate course in aquaculture
Stellenbosch University, in collaboration with Louisiana State University, WC	University	Offers a course in Stellenbosch, over three days. Aquaculture and Conservation or Aquaculture and Animal Science are the two majors available for the Bachelor of Science (BSc. Agric) offered by the Department of Animal Science. Additionally, brief courses and aquaculture training are provided by the Department of Genetics' Division of Aquaculture.
Rhodes University (Eastern Cape)	University	With assistance from DFFE, veterinarians and agriculture extension agents can take short courses in aquaculture. Courses in aquaculture are available for undergraduate and graduate study in the Department of Ichthyology and Fisheries Science.
University of the Western Cape	University	Department of Botany and Zoology – offers post-graduate courses in aquaculture
University of KwaZulu-Natal	University	The Department of Microbiology provides a post-graduate course in the microbiological aspects of aquaculture.
University of the Free State	University	Offers courses for post-graduate students specialising in aquatic parasitology and undergraduate students studying freshwater ecology
Nelson Mandela University (EC)	University	Undergraduate courses in Aquatic Ecology and Applied Aquatic Science are offered by the Zoology Department.
University of Limpopo	University	Freshwater finfish are the main subject of post-graduate aquaculture courses offered by the Aquaculture Research Unit.
University of Zululand Zoology Department (KZN)	University	Provides undergraduate and graduate courses, with an emphasis on aquaculture.
Cape Peninsula University of Technology (Western Cape)	University	Undergraduate and graduate courses with aquaculture components are available through the Department of Biodiversity and Conservation.
Elsenburg Agricultural Training Institute (Western Cape)	Agricultural Training Institute	Provides a course on animal production in aquaculture production.

Institution	Type	Offering
Glen Agricultural Training Institute (Free State)	Agricultural Training Institute	Offers ad-hoc informal training, in partnership with the Xhariep Fish Hatchery Project and private training providers
Madzivhandila Agricultural Training Institute (Limpopo)	Agricultural Training Institute	Module in aquaculture (animal production), five-day certificate of attendance
Tompi Seleka College of Agriculture	Agricultural Training Institute	Module in aquaculture (animal production)
Tsolo Agriculture and Rural Development Institute (TARDI) (Eastern Cape)	Agricultural Training Institute	Provides a module on aquaculture, and trains advisors and educators on aquaculture.

Source: AgriSETA (2020)