



Analysis of Production Capacity, Profitability, and Constraints in The South African Aquaculture Industry: Case of Gauteng Province Food Fish Aquaculture

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ABSTRACT

Gauteng province's aquaculture was grossly underdeveloped and very little was known about its profitability and the possible constraints faced by its operators. Hence, this study was conducted to assess the production capacity, and profitability of existing aquaculture projects and to identify the constraints responsible for the underdevelopment of the industry in the province. To achieve these, data was collected from five fish farms located in the province using structured questionnaires and interviews. Gross margin analysis and gross profit margin ratio were used to determine the profitability of aquaculture production. The fish farmers in the study used 36% of the capacities of the established aquaculture projects leading to lower tonnage of fish per cycle of production in all the farms. This is an indication of the underutilization of the production capacities of the established fish farms. The profit margins were greater than 40% in all the projects surveyed, proof that aquaculture has good potential as a business enterprise in the province. However, the study identified several constraints which include lack of skilled workforce, poor access to funding, and lack of established input suppliers within the province as being responsible for the underdevelopment of the sector.

Keywords: Aquaculture, profitability, production capacity, constraints, underdevelopment

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Introduction

Aquaculture is the fastest-growing food production sector in the world (Edwards et al. 2019), and Africa is an aquaculture destination of choice due to the continent's favorable environmental conditions, with approximately 43% potential area for farming tilapia, African catfish, and carp (Adeleke et al. 2021). Several African countries including Egypt, Nigeria, Uganda, and Ghana are making significant contributions to global aquaculture by serving as the continent's main aquaculture destinations (Adeleke et al. 2021).

Although South Africa has one of the most well-developed infrastructural networks, and conducive environmental conditions suitable for aquaculture development in the continent (Britz and Venter

2016), however, aquaculture development in the country is still at developmental stages. The country's contribution to global aquaculture production is insignificant compared to the leading African contributors (Adeleke et al. 2021; FAO, 2020). According to Ortega et al. 2021, the South African aquaculture sector made an annual contribution of about 6400 tonnes of fish to the total South African fisheries industry in 2018, while the country placed tenth among the African 10 aquaculture-producing countries, contributing 0.28% of the total African farmed food fish production (Adeleke et al. 2021).

South Africa's aquaculture industry is separated into marine and inland aquaculture. The sector is geographically diversified across all nine provinces that comprise the country. The province of the

Western Cape is the economic center for aquaculture output. It is also the country's most major contributor to GDP in terms of aquaculture exports. Other significant contributing provinces include Eastern Cape and Mpumalanga (DAFF 2018a).

Gauteng province is one of South Africa's warmest provinces. While winter temperatures can range between 5° and 19° celsius, bringing frost and frigid mornings, summer temperatures can range between 17° and 28° celsius and can last up to 8 months out of the year (Moja Media 2015). The province is ideal for warm water fish, particularly tilapia and catfish, with temperatures ranging from 20° to 30° celsius (Hecht et al. 1988; FAO 2011).

DAFF (2014) rated the province fourth in terms of overall freshwater fish production and the number of fish farms operating in the province in 2013 (DAFF 2019). In 2011, Gauteng province was in a distant third in the export of fish and aquatic invertebrates. The province exported 105,312 tonnes which made 2.99% of total national exports, trailing behind Western and Eastern Capes respectively (DAFF 2014). These export products were not only provincial products, but also products brought into the province from other parts of the country, indicating the province's poor aquaculture production (DAFF 2014).

Despite its current output, the aquaculture business in Gauteng province has a bright future. Because the province has a huge population, including expatriates from fish-eating countries across the world, it has a large potential market for aquaculture products. However, due to the non-commercial character of the aquaculture industry in the province, production estimates for the sector are underreported just like for the rest of the country (DAFF 2013). And despite the high market potential, nothing is known about the province's aquaculture venture's profitability. Little or no thought has been given to the business's viability or the elements that influence it. Rather, research has concentrated on issues such as fish biology, production, growth processes, and nutrition. However, aquaculture production involves more than just fish growth processes; it also entails paying attention to the financial aspects of production, which aids in better decision-making and progress. Aquaculture financials are important for promoting commercialization, obtaining capital, and convincing investors of the enterprise's profitability (Mwangi 2007; Kaminski et al. 2018). The lack of knowledge on aquaculture profitability affects not just the farmers who produce fish, but also all stakeholders who may be interested in engaging in the sector.

The purpose of this study therefore was to assess the production capacity and profitability of existing aquaculture projects, as well as to identify the

constraints causing the underdevelopment of the sector in Gauteng province, despite the availability of strong support structures and enabling environment.

Materials And Methods

Study Area

The research was carried out in South Africa's Gauteng area. Gauteng province is the smallest of South Africa's provinces, accounting for around 1.5% of the country's total geographical area (Dlamini et al. 2022). However, it is the most populous of South Africa's nine provinces and has been named the country's economic center and gateway to the country (Gauteng City-Region Observatory [GCRO] 2016; Dlamini et al. 2022). The province has the highest migrant population, with a combined total migrant population that exceeds the total of all other provinces (Dlamini et al. 2022).

The aquaculture industry in Gauteng province is underdeveloped compared to provinces like Western and Eastern Capes or Mpumalanga of South Africa. The province was ranked fourth by DAFF (2014) in terms of the total freshwater fish production and the number of fish farms operating in the province in 2013 (DAFF 2014).

Gauteng province is mainly an urban province. However, its agricultural sector makes up a small share of the economy providing the cities and towns with daily fresh produce (GCIS 2004; Makiti Guides and Tours 2009). In terms of climatic conditions, the province falls within the areas with hot summer and cold winter making it generally too cold for warm water fish and too hot for cold water fish (GCIS 2004).

Tilapia is the most common farmed species in the province. *Oreochromis mossambicus* was a predominantly farmed species in the past because it is indigenous to South Africa. However, most farms have replaced *O. mossambicus* with the fast-growing *Oreochromis niloticus* which is listed as an alien invasive species in the country (DAFF 2018b). Tilapia species is embraced in Gauteng province because of its white flesh for which it has been dubbed "aquatic chicken", and also due to the presence of foreign African nationals who are from countries where fish consumption is valued as well as South Africans who are imbibing the art of healthy eating.

The African sharptooth catfish, *Clarias gariepinus*, is another food fish which are being farmed in the province but whose production is not very high because they are difficult to sell due to their red color, meaty texture, and distinct muddy flavor (Stander 2007). Local buyers found its appearance unappealing and the cost price often too high. However, African catfish is sought after by some immigrants from some African regions where it is

regarded as a delicacy (Britz 2015). Other fish species produced in the province include carp, prawns, and ornamental fishes (DAFF 2019).

Sampling

Primary data for the study were collected using snowball and convenience sampling methods. The snowball sampling method is a referral-based non-probability sampling approach. The method is to find someone who is a good fit for the study and then have that person recommend other people (Kirchherr and Charles 2018). Each respondent was contacted by phone prior to the formal survey. After the respondent accepted the survey, the purpose of the study was explained, and a formal appointment was scheduled. According to Gauteng Department of Agriculture and Rural Development database, Gauteng province had 14 operable food fish aquaculture farms. However, as of the time of this study, only six of the listed farms remained in operation while three were partially functional. The remainder had either closed or the owner had discontinued fish production for a variety of reasons. Therefore, acquainting with one project led to the other projects by recommendation and referral. All the identified project owners were contacted. Only five, however, volunteered to be interviewed.

Data Analysis

All obtained data was coded and recorded into a Microsoft Excel 2010 spreadsheet before being uploaded to the Statistical Package for Social Sciences version 24 (SPSS 24). The descriptive features of the respondents, such as frequencies, percentages, mean, and standard deviation, were examined using Microsoft Excel and SPSS 24. In terms of profitability, a range of management strategies for assessing profitability in agricultural and other sorts of enterprises have been established. Many studies have employed techniques such as cost-benefit analysis (CBA), net present value (NPV), internal rate of return (IRR), gross margin,

and net revenue. Each strategy is determined by elements such as investment size, investment period, and business objectives (Kamangira et al. 2014). The gross margin was used as an analysis method in this article to determine the profitability of aquaculture ventures in the province.

Gross Margin and Gross Margin Ratio Analyses

The gross margin is the overall income generated by an enterprise less the variable costs incurred by the enterprise while the gross margin ratio which is a measure of a company's efficiency measures the ratio of the gross margin and total revenue generated. The bigger a company's profit margin, the more efficient it is. Because of its accuracy in profit assessment, gross margin has been employed in numerous research and appears to be the method of choice in profitability calculation (Nkademeng et al. 2021; Sambo et al. 2021; Ogundari and Ojo 2009).

The gross margin and the gross margin ratio were denoted by:

$$G.M = TR - TVC$$

$$GMR = GM/TR$$

Where:

$G.M$. stands for gross margin, $G.M.R$ stands for gross margin ratio, TR = Total revenue (from fish sales), TVC is the Total variable cost (which includes feed costs, labor costs, electricity costs, maintenance expenses, and so on).

Results

Farm Production Capacity and Current Production

The production capacities of each participated project and the current capacity utilization are presented in Figures 1, 2, and 3. Figure 1 shows the farm capacity while Figure 2 shows the actual usage of each farm that participated in the study. The outcome shows that none of the farms are operating to full capacity.

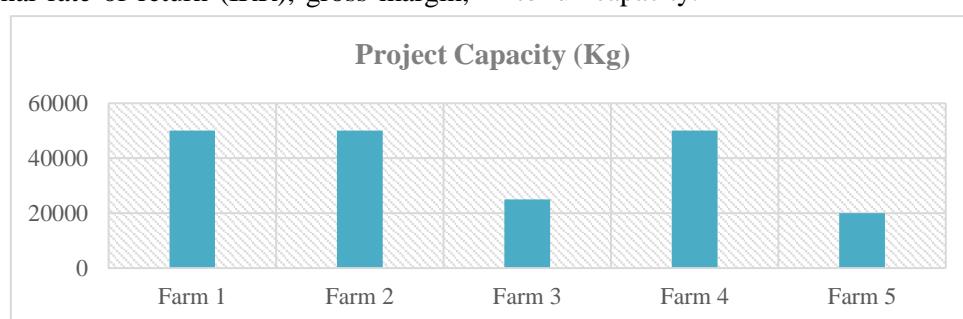


Figure 1. Aquaculture project capacity

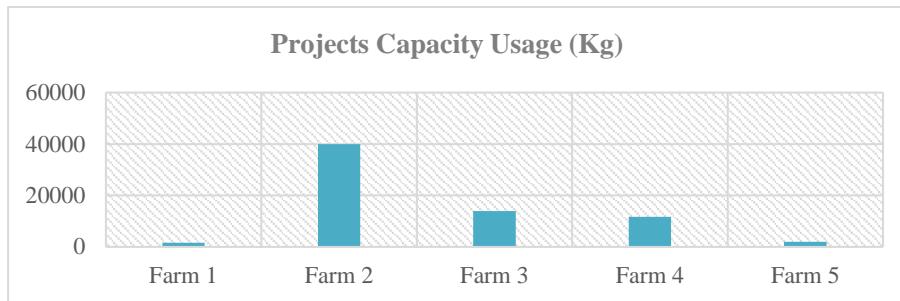


Figure 2. Aquaculture project active capacity

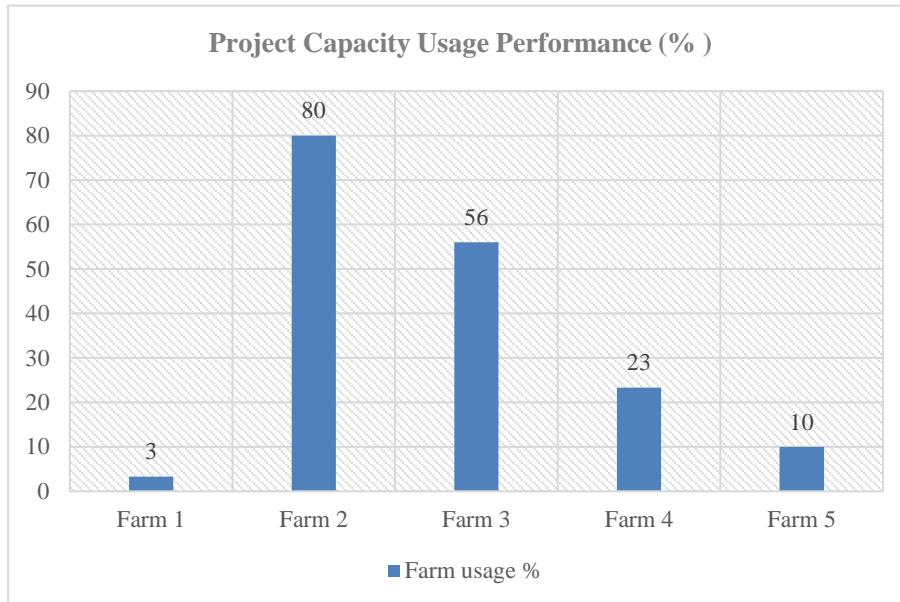


Figure 3. Aquaculture project capacity usage performance

Figure 3 indicates that only farms 2 and 3 are being utilized at above 50% of their total capacities, all the other farms are greatly underutilized.

Productivity and Profitability of Aquaculture Operations Investigated

To produce fish, either in table-size, juvenile, or fingerling sizes, many inputs are necessary. Such inputs include fixed and variable inputs. Fish farming is one of the agricultural activities undertaken by responding farmers in the same location. This is done in the same place as other farm practices such as vegetable cultivation, piggery, and cow breeding. As a result, the endeavors share the same inputs. And because no fixed input could be ascribed to the aquaculture firm due to the interlaced usage of the inputs, aquaculture productivity could not be established but inferred from production and utilization. A gross margin analysis was used to determine profitability.

Gross Margin and Gross Margin Ratio Analyses

Table 1 summarizes the gross margin ratios from the farms studied. The least gross profit for the production cycle analyzed was R33 334 for the five

farms on which the gross margin was calculated, while the maximum was R840 000. The disparities in profit between farms were considered to be attributable to the scale of production as well as the amount of management used throughout production, which included timely and efficient feeding as well as water quality management.

Constraints Limiting Aquaculture Development in Gauteng Province

Table 2 summarises the issues that farmers face. According to the survey results, there are numerous restrictions impeding the growth of aquaculture in the province. However, a lack of qualified labor in aquaculture seems to be a problem shared by all of the farmers who responded to the poll. Concerning financing, all of the farmers complained about not being able to obtain funds from the government or banks. Farm expansion is unfeasible due to a lack of funds.

Other obstacles highlighted by respondents included a ban on the cultivation of other species of tilapia other than Mozambique tilapia, as well as government laws and regulations governing the subsector, notably around fish importation.

Table 1. Gross margin output of fish production

Variables	Farmer 1	Farmer 2	Farmer 3	Farmer 4	Farmer 5
Total production per cycle (Units)	5 000	120 000	42 000	35 000	6 000
Unit production cost (Rand/Kg) *	25	25	26	26	22
Total production cost (Rand)**	41 666	1 000 000	364 000	303 333	44 000
Selling price per kg (Rand)	45	46	46	45	45
Total revenue per cycle (Rand)	75 000	1 840 000	644 000	525 000	90 000
Gross margin (Rand)***	33 334	840 000	280 000	221 667	46 000
Gross margin ratio	44	46	43	42	51

*Unit production cost includes the cost of fingerlings, labour, feed, electricity etc.

**Total production cost = Unit production cost multiplied by number of fish produced in kilogram

***Gross margin = Total revenue – Total production cost

Table 2. Constraints to the growth of aquaculture as indicated by fish producers

Farmers	Constraints experienced by farmers				
Farm 1	Lack of skilled worker	Limiting government policies	Lack of labor knowledge of fish		
Farm 2	Poor legislation	Erratic power supply	Poor extension	Underdeveloped market	
Farm 3	Lack of knowledge of system design	Oxygen control	High cost of heat generation	Unavailability of fish seed	Unavailability of fish feed
Farm 4	Poor funding	Lack of skilled worker	Limiting policies		
Farm 5	Unavailability of Broodstock	Lack of passionate workers	Lack of skilled worker	Erratic electricity supply	

Discussion

Human capital is one of the variable components employed in aquaculture production, as is electricity in the case of the Recirculation Aquaculture System (RAS), which is the type of aquaculture production system used in the province. Water, feed, and oxygen are also variable inputs. All the participated fish producers were unable to assign costs to the numerous inputs utilised in their farms for fish production. They do, however, have an evaluation system which is the production of a kilogram of fish at a particular cost. As a result, the farmers were only able to give the price of producing one kilogram of fish per cycle of production. This production cost was used to determine the gross margin of each farm surveyed. All the analysed farms had a positive gross

margin, indicating that the aquaculture industry in Gauteng Province is earning a healthy return on sales while keeping overhead expenses under control.

Based on the estimated gross margin ratios from the aquaculture operations in this study, it can be concluded that fish farming in Gauteng Province is profitable. Findings from several agricultural studies using gross margin and gross margin ratio have yielded similar results and conclusions: Southwest Bangladesh aquaculture (Siddiq et al. 2018), tilapia farming in Southern China (Matlala 2014), shrimp culture in Song Cau district, Vietnam (An 2012), Nguni cattle farmers in Limpopo (Nkadimeng et al. 2021) and Menchum River Valley rice production in Cameroon (Bime et al. 2014). However, Boyd et al. (2020) on the other hand, emphasised the importance

of good planning and operation by aquaculture farmer for sustainable growth and profitability.

Due to the industry's limits, none of the farmers interviewed were working their farms at full capacity. Only one farm was using more than 50% of its complete capacity, while the remainder were significantly underused. According to farmers, the main restrictions affecting the underutilization of farm facilities include a lack of funding, higher input costs, and a shortage of qualified manpower. The farmers were all aware of the government's intention to fund aquaculture. However, the procedures for obtaining the funds are time-consuming. All except one farmer claimed to have been able to access government funding at one time. All the other farmers claimed to run the farms out of their personal funds. The inability to obtain finance is a significant barrier. As a result, because intense commercial aquaculture is costly to create and run, fish farming in Gauteng Province has stayed on a limited scale. This finding is consistent with the findings of Sebola M.P (2018), Madibana et al. (2020). The investigations revealed that the majority of fish farmers were unable to obtain funding and hence could not grow as planned.

Another restraint was the prohibition on the production of other tilapia species other than Mozambique tilapia. However, due to the slow growth of Mozambique tilapia, farmers favored Nile tilapia, which grows quickly and is commercially viable. According to the farmers, getting a government permit to cultivate Nile tilapia, was a difficult task. Britz et al. (2009) identified this constraint as a major impediment to the development of aquaculture enterprises in South Africa as a whole, and Madibana et al. (2020) repeated the same opinion as a key point that the government should investigate to promote the expansion of aquaculture in South Africa.

Other obstacles mentioned by the farmers include government policy as well as subsector regulation. On a personal level, some other challenges that farmers face regularly include power outages, which always entail the need for alternate sources of power supply, resulting in a rise in production expenses as well as the cost of fish products.

Another obstacle faced by farmers, particularly those planning to enter the industry of producing fish fingerlings and young fish, is the issue of brood stock. A major barrier is the country's lack of sources for purchasing brood stock. The government's regulation of fish importation is a major impediment to the subsector's expansion. Only one of the five farmers who responded can grow fingerlings for table-size fish production. As a result, the other farmers had to rely on him for their fingerlings and juvenile fish. The remedies to the province's limits to aquaculture

expansion are unique to the country as a whole. These limits are mentioned in the works of Hecht et al. (1988), and Madibana et al. (2020).

According to the study's findings, aquaculture projects in Gauteng province are producing below capacity. This is evident from each project's output capacity and actual present use. At maximum capacity utilization, the combined total production should have been 195 tonnes of fish. For this survey, only roughly 70 tonnes of total fish production were documented. The current use equals 36% of the overall capacity of the farms.

Several constraints in aquaculture productivity were identified. Nonetheless, despite the sector's problems and underproduction, fish farming in the area is profitable. While one of the farms had a gross margin ratio greater than 50%, all the other farms had a gross margin ratio greater than 40%. This demonstrates that aquaculture is a viable business. The initiative has the potential to contribute to the government's socioeconomic goals of job creation and poverty eradication.

To aid the growth, development, and profitability of aquaculture in Gauteng province, government agencies, and non-governmental groups must raise youth awareness in order to stimulate fish farming in the province. In addition, legislation for aquaculture practices is needed to overcome current rules, particularly those that do not promote aquaculture in the province. Furthermore, there is a need to develop a full-fledged department of aquaculture management in institutions around the province to support aquaculture study and research. It is also critical for the government to make it easier for farmers to access the funds set aside to encourage aquaculture in the province.

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