

# An Assessment of Aquaculture Performance in Chinsali and Shiwang'andu Districts of Muchinga Province, Zambia.

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## ABSTRACT

A study was conducted to assess the performance of aquaculture in Chinsali and Shiwangandu districts of Muchinga Province. A total of 162 respondents were randomly selected and interviewed using a semi-structured questionnaire in both locations. In addition to primary data, conclusions were drawn from supplementary sources such as journals and reports. The data were analyzed using the Statistical Package for Social Sciences (SPSS). The survey results revealed that 10% of the respondents were between 20 and 30 years old, 43% were between 31 and 40 years old, and 33% were between 41 and 50 years old. Small-scale farmers constituted the vast majority (96%) of respondents, while medium-scale farmers accounted for only 4%. The majority of respondents either hired labourers or constructed earthen ponds with their families. Despite the recommended stocking density of 3 fish/m<sup>2</sup>, many farmers relied on vendor recommendations to find high-quality seeds and set their prices between ZMK0.5 and ZMK1, respectively. More than 50% of participants believed that selling fish provided an opportunity to make money. However, due to a lack of education, farmers did not keep records of the fish they raised, making it difficult to predict the exact fish yield after sale in ponds at prices ranging from 20 to 40 ZMK per kg. Most of the respondents used only one ingredient or additive in their feed and occasionally applied manure fertilizer to their ponds. Complete feed was very expensive, and farmers' inability to access lines of credit for financing and expansion was another problem. Despite these challenges, there is great potential for a thriving and highly productive aquaculture sub-sector to benefit an increasing number of government officials, as the fish market is known for providing high-quality protein and services to an increasing number of stakeholders.

**Keywords:** Assessment, Aquaculture performance, Chinsali, Shiwang'andu, Muchinga Province

## INTRODUCTION

The practice of aquaculture, specifically fish farming of the cichlid family, has been implemented in Zambia for numerous decades. Its origins can be traced back to the 1950s, when the Joint Fisheries Research Organization (JFRO) first attempted to cultivate indigenous species of the Cichlidae family, primarily tilapias, in dams and earthen fish ponds (Nsonga and Simbotwe, 2014). Since then, various small to medium-scale private sector entities have entered the sector, with a predominant focus on pond fishery, beginning in the 1980s (ZAEDP, 2016). These actors have adopted fish farming as a means of diversifying their

livelihoods (Kaminski *et al.*, 2019), utilizing ponds and other enclosures for food production.

Aquaculture plays a crucial role in providing both proteins and micronutrients, particularly in low-income countries like Zambia. It has the potential to be as significant as agriculture for smallholder producers in terms of socio-economic development and food security, as noted by Longley *et al.* (2014) and Kaminski *et al.* (2020). Fish and fish products constitute over 20% of animal protein consumption in Zambia, providing essential micronutrients for a significant portion of the population, as highlighted by Musumali *et al.* (2009) and Kapembwa and Samboko (2017). Despite the involvement of approximately 21,429 smallholder farmers in fish farming, accounting for only 11% of the total fish supply (DoF, 2017; Namonje-Kapembwa and Mofya-Mukuka, 2018), the growth of small-scale aquaculture producers in Zambia has been hindered by various factors such as increased demand, reduced availability of high-quality seeds and fish feed, high production costs, market constraints, and concerns regarding product quality and safety (FAO, 2020).

Despite being the fastest-growing commercial food production industry in the nation and holding a noteworthy position in the economy (FAO, 2012), aquaculture is confronted with a considerable shortfall in the supply of superior fish in the country, with an estimated 46% of the projected demand remaining unfulfilled through domestic production (African Development Bank AfDB, 2016).

In recent years, Zambia's aquaculture industry has attracted significant attention from major aquaculture companies, particularly in the Copperbelt, Lusaka, and Southern provinces (ZAEDP, 2016). This development has presented new investment opportunities for farmers to establish large-scale cage-based fish farming facilities (ZAEDP, 2016) and enhance production by accessing high-quality commercial inputs (Kaminski *et al.*, 2019). The adoption of efficient management practices, such as the utilization of high-quality seeds and commercial feed, and the monitoring and tracking of feed conversion ratios (FCRs), can significantly benefit large and medium-sized farms, particularly those with cage farms. Consequently, these farms can produce superior quality and larger fish for the urban market (Avadi *et al.*, 2019).

The government, in conjunction with its partners, has implemented several initiatives to promote the aquaculture sector as a viable and comprehensive business opportunity for small and medium-sized enterprises. In 2017, the African Development Bank (AfDB) provided support for the Zambia Aquaculture Enterprise Development Project (ZAEDP) at a total cost of US \$50.89 million. The aim of this project was to develop the country's aquaculture sector, which represents a complete and sustainable business opportunity through increased production and productivity, thereby improving the lives of both men and women who benefit from the long-term value of aquaculture (AfDB, 2016). This project also supports research and knowledge development in collaboration with the World Fish and national universities to improve fish genetics and develop the main factors that lead to the improvement of native fish species (ADB, 2016).

Increasing the level of investment in aquaculture within the Muchinga province of Zambia would significantly contribute to the production of sufficient fish for both local consumption and exportation, thereby generating employment opportunities for the youth, particularly in Chinsali and Shiwang'andu (DoF, 2017). The Aquaculture Seeds Fund, under the administration of the Citizens Economic Empowerment Commission (CEEC), has extended support to the aquaculture sub-sector in the Muchinga province. The fund has disbursed approximately K27 million to farmers in the province, with the objective of strengthening the aquaculture value chain (Zambia National Broadcasting Corporation, 2019). The province is home to two major aquaculture facilities, namely the Chinsali Aquaculture Research Station (CARS) and the Isoka Government Fish Farm (IGFF). A comprehensive analysis of the performance of the aquaculture sub-sector in Chinsali and Shiwang'andu districts was conducted to identify the number of fish farmers operating on both small and commercial scales, as well as the challenges they faced and the opportunities available.

## MATERIALS AND METHODS

### Study Areas

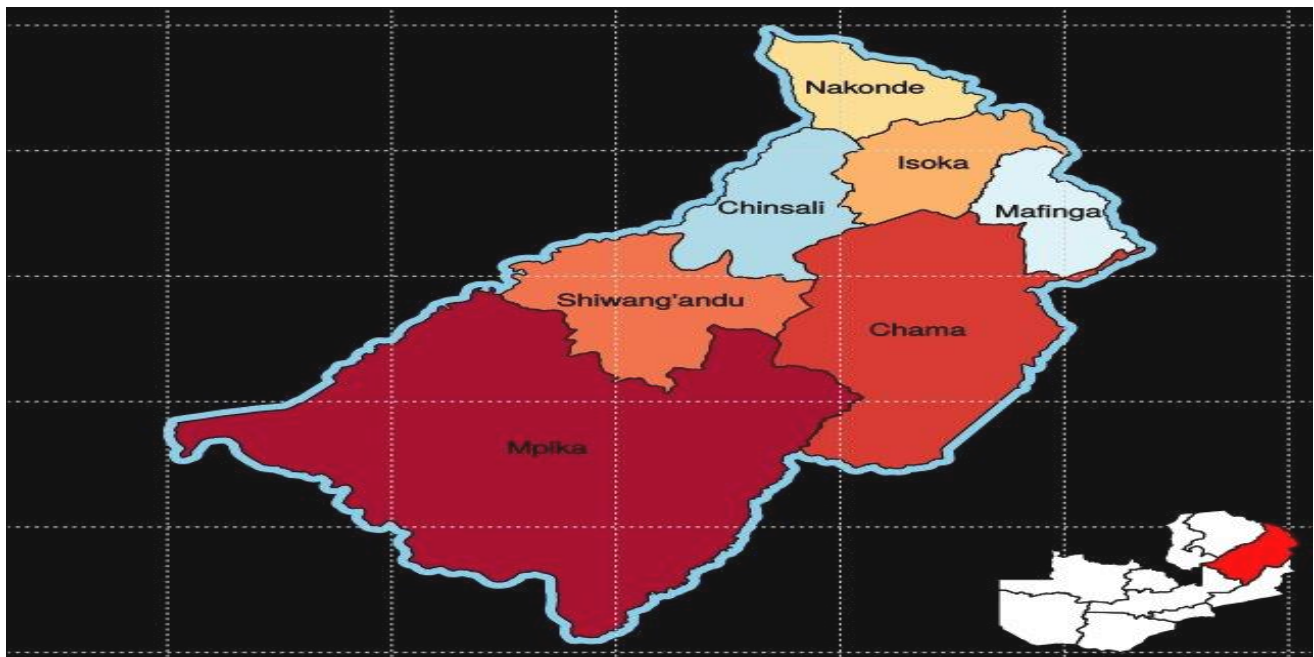


Figure 1: Map showing the study areas

#### Chinsali district

The district in question is situated in the Muchinga Province and was designated as the provincial headquarters in 2011. The populace of the district relied solely on agriculture, cultivating crops such as maize, sorghum, cassava, and millet, as there are currently no significant industries operating in the area. Fishing and fish trading were also among the activities undertaken by the locals.

The geographic coordinates of the district were  $10^{\circ} 33' 0''$  South and  $32^{\circ} 4' 0''$  East, with an elevation of 13335 metres above sea level. The northeastern half of the district is predominantly a plateau. Its neighbouring districts include Shiwangandu to the south, Chama to the east, Isoka to the northeast, Nakonde to the north, and Mungwi to the northwest (National Geospatial-Intelligence Agency, 2018; Muchinga Provincial Administration, 2022).

Chinsali experiences a humid subtropical climate characterized by moderate temperatures and regular rainfall cycles. The region's annual average rainfall of 1100mm was believed to be primarily due to a single season lasting from October to April. The annual mean temperature ranged from  $16^{\circ}$  to  $24^{\circ}\text{C}$ , with maximum temperatures of  $34.6^{\circ}\text{C}$  being recorded. The Bembas, Bisa, and Namwanga were the three main ethnic groups in terms of population (National Geospatial-Intelligence Agency, 2018; Muchinga Provincial Administration, 2022).

#### Shiwang'andu district

Shiwang'andu is one of the eight (8) districts in Muchinga Province, located in the northeast of the country. It is approximately 716 km from Lusaka, the capital city, and 103 km from Chinsali, the provincial capital of Muchinga Province. The district was established by a parliamentary act in 2012 and began functioning in 2013. Shiwang'andu shares borders with Kasama District to the west, Mungwi District to the northwest, Chama District to the east, Mpika District to the south, and Chinsali District to the north. Its geographical coordinates are between latitudes  $10^{\circ}14'$  and  $11^{\circ}32'$  south of the equator and longitudes  $31^{\circ}4'$  and  $32^{\circ}39'$

east of the Greenwich Meridian, with an elevation ranging from 1000m to 2000m above sea level.

Originally named Ishibang'andu, which translates to "lake for crocodiles," the district's name was changed after white people had difficulty pronouncing it. The district covers a total surface area of about 9,837 km<sup>2</sup> (983700Ha), with 96% of the land being traditional and 4% (32,000Ha) being state-owned. The district comprises seventeen (17) wards and 88 zones, with 25% of the land being mountains, wetlands, and game management areas, and 60% being arable. According to the Central Statistics report, the district's population was 59,975 as of 2010, with a growth rate of 1.4%.

Shiwang'andu is home to three chiefs: Chief Kabanda, Chief Chibesakunda, and Chief Mukwikile. The district boasts a diverse range of cultural practices and traditions, which are also a part of the tourism component due to the various ethnic groupings present in the area (Muchinga Provincial Administration, 2022).

### **Research Design and Sample Size**

The research was conducted in the Chinsali and Shiwang'andu districts of the Muchinga province, which collectively had a farmer population of 542, along with 1156 fish ponds (DoF, 2017). The chosen respondents were interviewed using a semi-structured questionnaire.

#### **Sample size**

In this study, the probability sampling technique was employed due to its ability to enable the researchers to precisely determine the likelihood of each sampling unit being included in the sample. To ascertain the appropriate sample size from the population, a statistical formula was utilized in instances where the population was known. The sample size was calculated with a margin of error of 5% and a confidence level of 95%. The formula employed for the computation of the sample size was as follows:

$$n = N * X / (X + N - 1),$$

Where,

$$X = Z_{\alpha/2}^2 * p * (1-p) / MOE^2,$$

And  $Z_{\alpha/2}$  is the critical value of the Normal distribution at  $\alpha/2$  (e.g. for a confidence level of 95%,  $\alpha$  is 0.05 and the critical value is 1.96), MOE is the margin of error,  $p$  is the sample proportion, and  $N$  is the population size.

### **Data Collection**

#### **Primary Data**

To attain the objectives delineated in the investigation, primary data was gathered via questionnaires and interviews. The data gathered encompassed the quantity of fish farmers at each farming scale, the number of fish ponds per farmer, the number of active fish ponds per farmer, the cost of a fingerling, the value of fish to a specific farmer, the expenses linked with pond construction, the cost of the harvested fish per kilogram, and the duration of time a particular farmer had been engaged in the business.

#### **Secondary Data**

The collection of secondary data pertaining to fish production in the two districts was conducted at the provincial fisheries office located in Chinsali. Supplementary literature was sourced from books, journals,

and online resources pertaining to fisheries and aquaculture.

### Data Analysis

The data analysis was conducted using the Statistical Package for Social Sciences (SPSS) version 15.0. To ensure standardization and facilitate statistical processing, each response was assigned a numerical code. The data for each variable was subsequently entered and analyzed using frequency tables. Exploratory data analysis was also performed using Microsoft Excel 2010, which included the creation of graphs and charts.

## RESULTS AND DISCUSSION

### Gender of randomly selected farmers in Chinsali and Shiwang'andu districts

As per the results of the study, it was observed that the Chinsali and Shiwang'andu districts had a significant proportion of male fish farmers (as depicted in Figure 2).

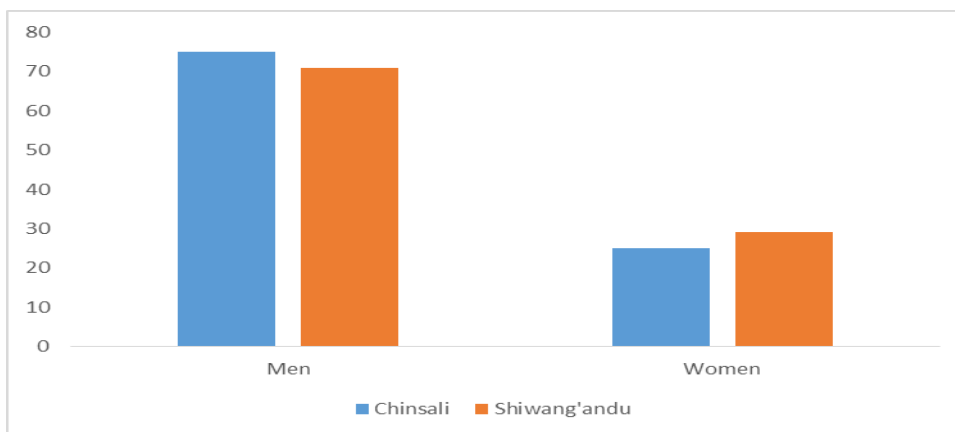


Figure 2: Gender of farmers in Chinsali and Shiwang'andu districts.

The findings of Mainza and Musuka (2015) agreed with the present study, as they reported that the majority of men were perceived to possess a strong drive to succeed. Under customary law, men were entitled to inherit land, which they could utilize as collateral for bank loans to establish any form of enterprise. The authors further indicated that the relatively low participation of women in fish farming could be attributed to a variety of factors, including their inability to access land as collateral when applying for bank loans to initiate fish farming activities, traditional beliefs that women should not engage in any fisheries-related activities, limited awareness to encourage women to venture into aquaculture, and a lack of government incentives to encourage women to enter the industry (Mainza and Musuka, 2015). Weeratunge-Starkoff and Pant (2011) also observed that the aquaculture industry was predominantly viewed as a male-dominated domain due to the high levels of investment and adoption of new technology associated with its development. Krishnan and Peterburs (2017), as cited by Avadi *et al.* (2022), revealed that women constituted a mere 10% of the workforce in the aquaculture value chain. The authors of that study also found that women were less inclined to pursue careers in aquaculture due to their perception that such jobs required significant physical strength. The fact that extension services were primarily targeted at men was another contributing factor, as some communities had come to believe that women were unsuited for the fish farming industry (Weeratunge-Starkoff and Pant, 2011).

Equally, Medard (2001) and Luombo (2014) contended that cultural, religious, taboo, legal, social, economic, and political factors all exerted an influence on the participation and roles of women in fish farming. Conversely, Obiero *et al.* (2017), citing Obwanga and Lewo, present an opposing viewpoint. According to Obiero *et al.* (2019), the low uptake of aquaculture among women, particularly among the

youth, poses a threat to the social sustainability of aquaculture.

In general, Figure 3 provides a comprehensive overview of the challenges encountered by women engaged in fish farming within the two designated research areas.

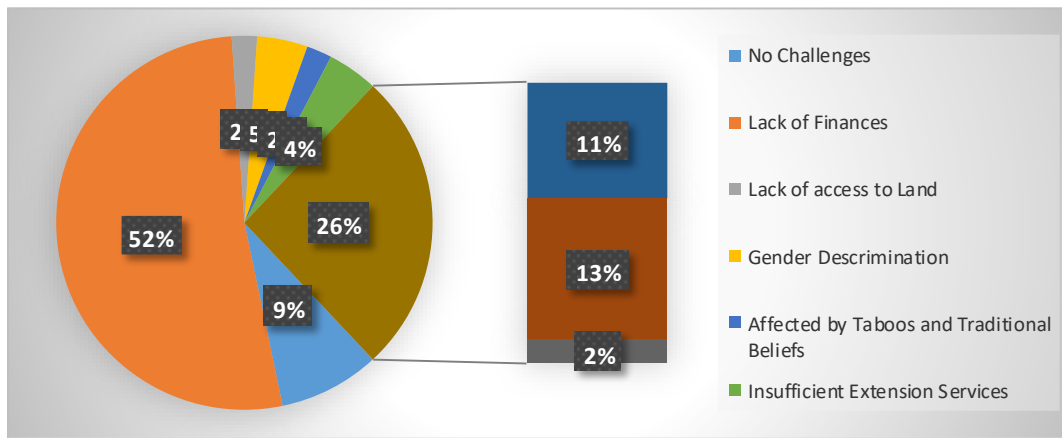


Figure 3: Challenges faced by women in fish farming

The age distribution of fish farmers in the Chinsali and Shiwang’andu districts of Muchinga province is depicted in Figure 4. It is noteworthy that a significant proportion of the farmers fell within the age bracket of 31 to 40 years, with their primary objective being to utilize fish farming as a means of sustaining their households and generating income.

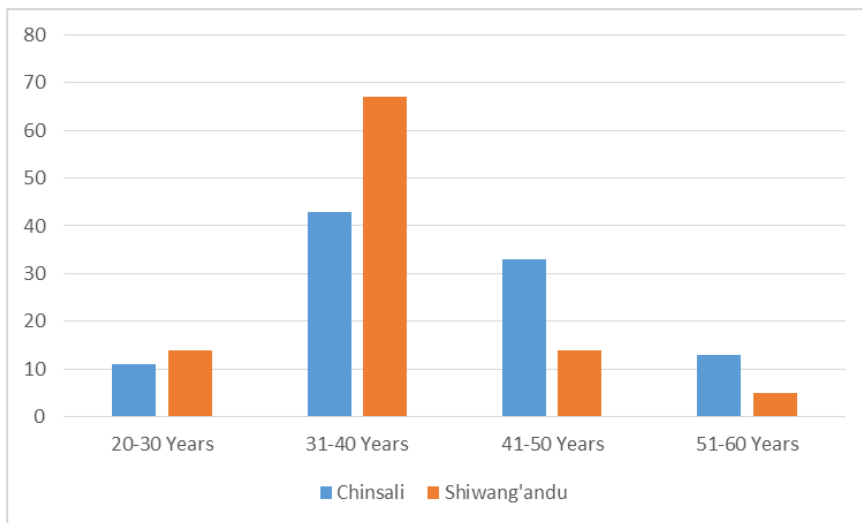


Figure 4: The demographic of farmers in the districts of Chinsali and Shiwang’andu with regards to age.

As per the findings of Koundouri *et al.* (2006) cited by Obiero *et al.* (2019), farmers who commenced their fish farming ventures at a younger age were presented with a greater prospect of expanding their businesses owing to their youthful vigour and anticipated prolonged tenure in the industry. The study further revealed that younger farmers exhibited a higher degree of creativity, evinced a preference for staying abreast of emerging technologies, and had longer-term planning horizons.

**The educational attainment level of fish farmers in the districts of Chinsali and Shiwang’andu.**

The present study has revealed that fish farmers have attained primary, secondary, and tertiary education, as depicted in Figure 5. The findings suggest that inadequate educational attainment poses a hindrance to the growth and advancement of the subsector. Furthermore, the exorbitant tuition fees charged by different educational institutions have impeded some of the respondents from pursuing higher education.

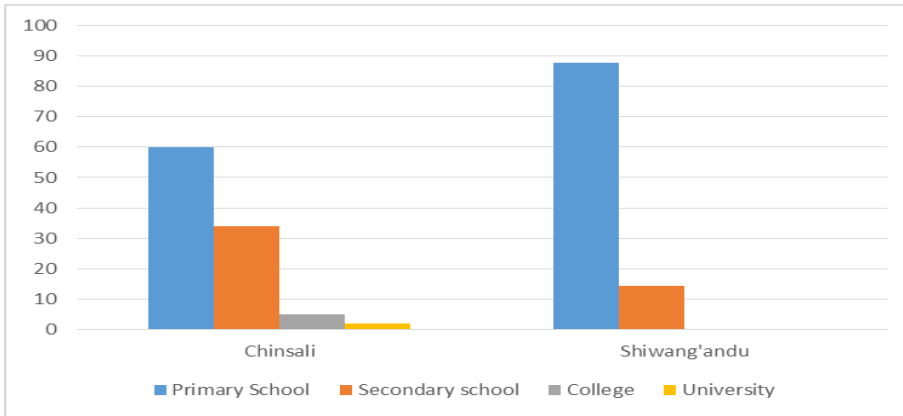


Figure 5: The educational attainment of farmers in the districts of Chinsali and Shiwang'andu

This is in agreement with the findings of a study conducted by Mainza and Musuka (2015) on the educational attainment of smallholder farmers. The exorbitant tuition fees charged by higher education institutions were beyond the means of the vast majority of individuals. Farmers with lower levels of education exhibited a reduced propensity to adopt new and improved innovations and technologies.

Banda and Musuka (2020), citing Muddassir *et al.* (2017), suggested that the adoption of superior fish farming practices may be impeded by the inadequate education levels of fish farmers. As small-scale fish farmers are required to monitor various aspects such as total production, fish mortality and diseases, input costs, total revenue generated from fish farming, and profitability, the presence of a significant proportion of individuals without tertiary education has an impact on fish production (DoF, 2017; Banda and Musuka, 2020). It would be prudent for extension agents to educate farmers on maintaining business records.

However, it is noteworthy that the majority of respondents were proficient in both Bemba, the local language in the study area, and English.

### Marital Status of the respondents

The marital status of the participants is depicted in Figure 6. The investigation revealed that Shiwang'andu exhibited a greater percentage of individuals who were married in comparison to Chinsali. Conversely, Shiwang'andu had a lower number of widows in total.

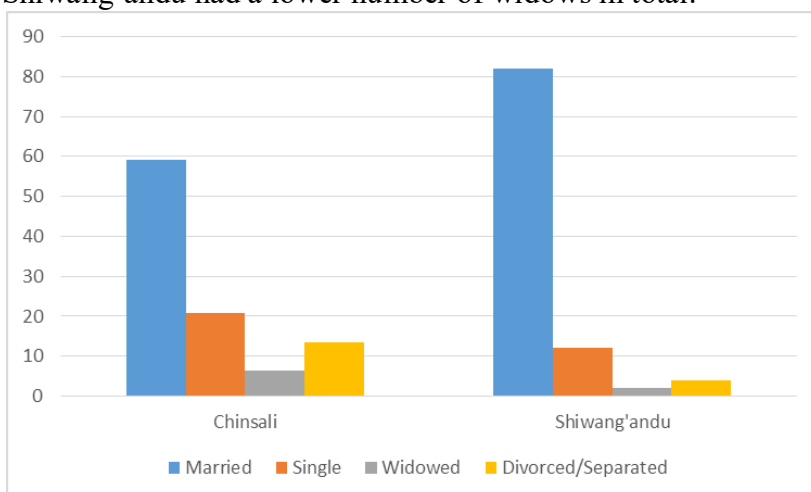


Figure 6: Marital status of farmers in Chinsali Shiwang'andu districts.

The majority of married farmers received assistance from their wives in carrying out various tasks related to fish farming. The ponds were typically owned as a family business, with the husband assuming a more

active role in managing the business. This study also demonstrated that wives and children played a significant role in day-to-day tasks by assisting with fish feeding, harvesting, and general pond maintenance. According to Luombo (2014), women have historically participated in various stages of operation in small-scale aquaculture. These tasks may include feeding the fish, sanitizing or stocking the pond, sorting, harvesting fish, treating sick fish with medication, transporting fish, and more (Luombo, 2014). A 2007 study by RPUK found that married women may legally own both normal and tangible assets, such as real estate or homes, through inheritance.

Furthermore, the study revealed that households with male heads outnumbered those with female heads in both districts (Fig. 7). In households with a male head, men made decisions, while in households with a female head, women made decisions. However, in male-dominated households, women were not free to make decisions for themselves; instead, their husbands made decisions on their behalf. This was a widespread practice that affected the self-confidence of women. Nevertheless, because they were better able to understand their needs than anyone else, women who were in charge of households had the power to decide what they believed would be in their best interests.

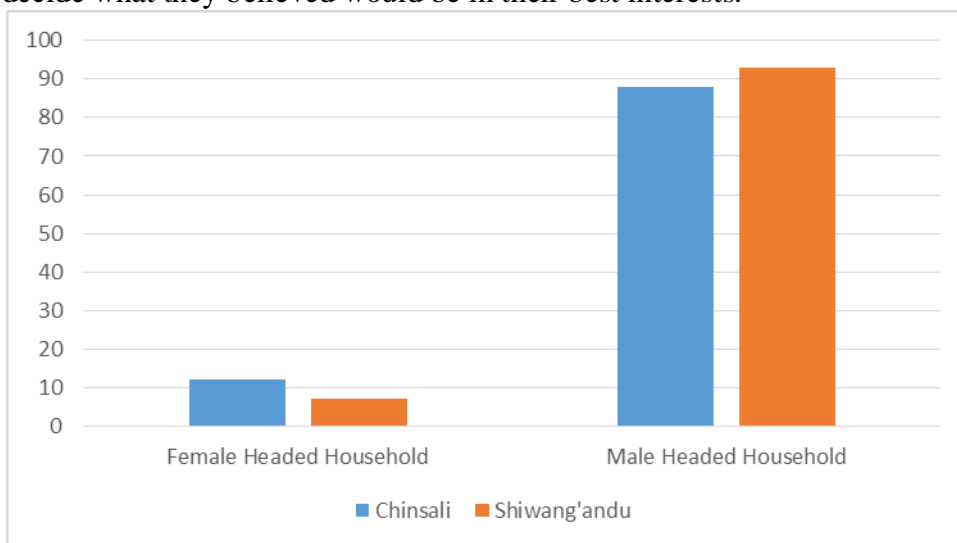


Figure 7: Household Head in Chinsali and Shiwang'andu districts

**The average number and size of ponds owned.**

The figure depicted in Figure 8 illustrates the customary quantity of ponds possessed by farmers, which exhibited variability among individuals. The investigation revealed that certain farmers possessed as many as 20 fish ponds, while the majority possessed between one and five.

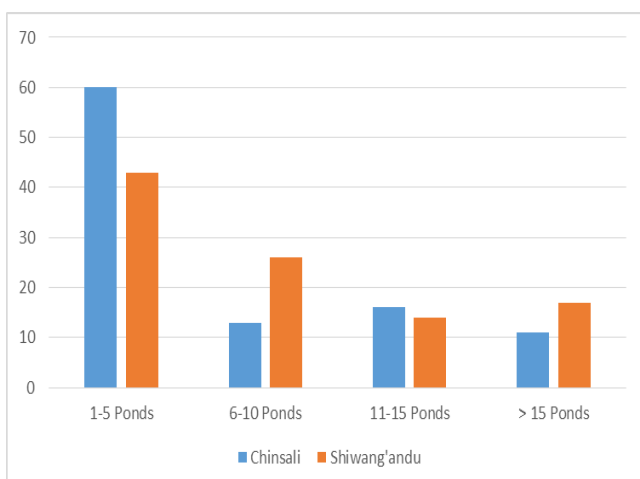


Figure 8: Pond ownership.



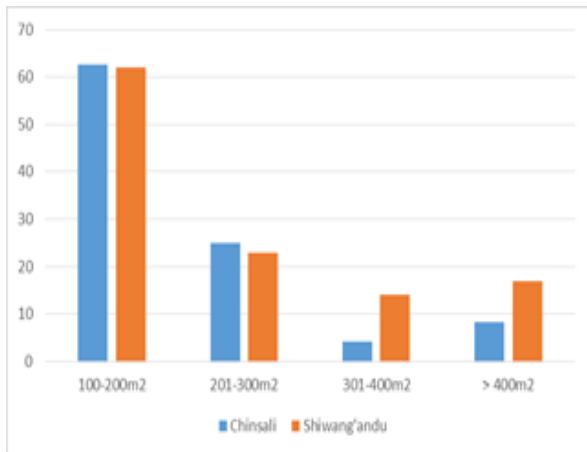


Figure 9: Individual farmer pond size in Chinsali and Shiwang'andu

According to Mainza and Musuka (2015), as cited by Banda and Musuka (2020), the majority of fish farmers in Zambia possessed ponds ranging from one to ten. Furthermore, it was discovered that men, in particular, owned more ponds and had larger land holdings than women. Nyaga *et al.*, (2016) observed that owning ponds had a positive impact on farmers' willingness to sell to traders. The possession of numerous ponds allowed for increased fish harvests, which encouraged the sale of fish in large quantities. The author indicated that a fish farmer's pond count served as a proxy for or a representation of wealth (Nyaga *et al.*, 2016).

The districts of Chinsali and Shiwang'andu practised fish farming in a manner similar to that observed in many African countries, with small ponds, subsistence-level management, and extremely low levels of production. According to this study, the majority of fish ponds in the Chinsali district were between 100 and 200 square metres in size (62.5%), 25.5% had ponds between 201 and 300 square metres in size, 4.2% had ponds between 301 and 400 square metres in size, and 8.3% had ponds larger than 400 square metres (Figure 8). In contrast, 62% of farmers in the Shiwang'andu district possessed ponds that were between 100 and 200 m<sup>2</sup> and 201 and 300 m<sup>2</sup> in size, respectively (Fig. 9).

**The length of time and years of experience in fish farming in Chinsali and Shiwang'andu districts of Muchinga province.**

The results of the study indicated that in Chinsali, 67% of the farmers who were sampled were novices in the industry, while 8.33% had been engaged in fish farming for over 15 years, as illustrated in Figure 10. Conversely, in the Shiwang'andu district, the majority of the farmers who were sampled had a range of 1 to 5 years of experience.

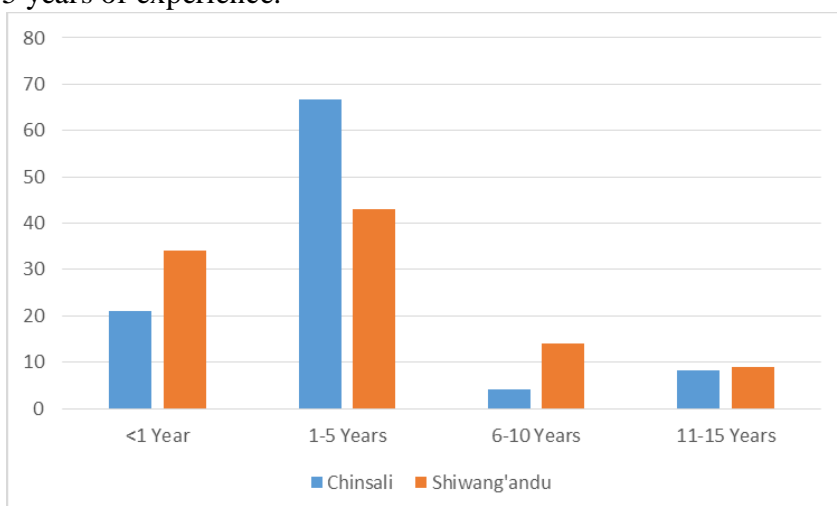


Figure 10: Fish farmers' years of experience in Chinsali and Shiwang'andu districts

As per the findings of the study, a significant proportion of fish farmers operating in the Chinsali and Shiwang’andu districts lacked substantial experience in the field of fish farming. It was observed that the aquaculture business was still in its nascent stage. Nevertheless, with an increase in the duration of engagement in fish farming, individuals tended to acquire a greater degree of expertise. This allowed them to develop essential skills such as problem-solving, teamwork, communication, and time management. However, it was noted that possessing more experience in the industry did not necessarily translate to better performance for a fish farmer.

**Justifications offered by the surveyed farmers in the Chinsali and Shiwang’andu districts regarding their decision to specialize in aquaculture.**

According to Figure 11, Shiwang’andu had a higher percentage of respondents (62%) than Chinsali (48%) who opted to pursue farming as a means of augmenting their income. The Department of Fisheries (DoF) in 2017 posits that the majority of individuals who ventured into the informal economy, such as fish farming, were those who were unable to secure employment due to Zambia’s poverty and its inability to accommodate its rapidly growing population. A World Bank report in 2010 similarly revealed that despite Zambia’s significant increase in real GDP, job creation only rose by 1% annually. Of the estimated 6 million workers, only approximately 14% were formally employed, with the remaining individuals either working in the informal economy or being unemployed.

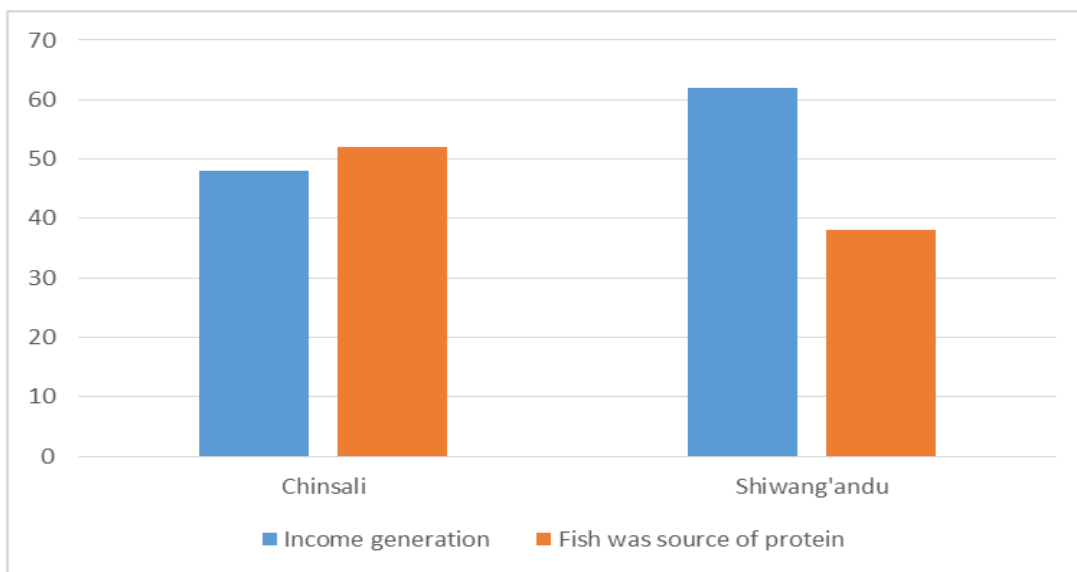


Figure 11: Reasons for venturing into fish farming in Chinsali and Shiwang’andu districts.

On the contrary, it is noteworthy that a considerable proportion of farmers in Chinsali and Shiwang’andu, namely 52% and 38% respectively, opted to engage in fish farming owing to its high protein content, as depicted in Figure 11. This trend is consistent with the findings of Mainza and Musuka (2015), who cited World Fish (2014) and highlighted the reliance of millions of disadvantaged individuals in Asia and Africa on a blend of fishing and agriculture for their livelihoods and sustenance.

**Various forms of labour employed and varying amounts of funds expended in the construction of ponds within the Chinsali and Shiwang’andu districts of the Muchinga province.**

The construction of ponds in the Chinsali district was accomplished through the utilization of approximately 75% family labour and 25% hired labour. In the Shiwang’andu district, fish farmers employed family labour for pond construction (71%) of the time, while hired labour was utilized (29%) of the time, as illustrated in Figure 12.

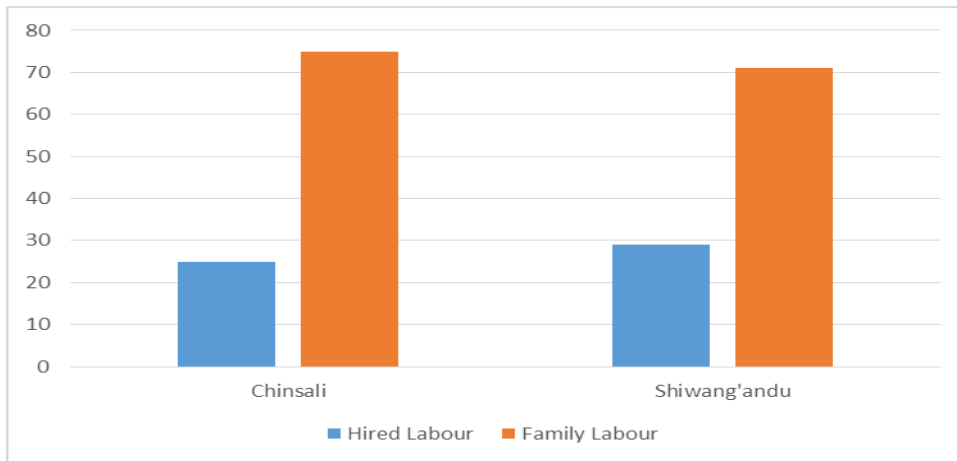
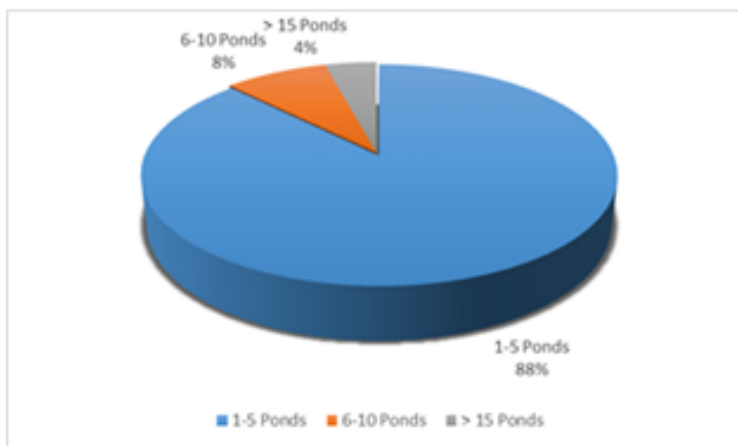


Figure 12: Type of labour used to construct ponds in Chinsali and Siwang'andu districts.

The study's findings unequivocally indicate that the expenses associated with constructing ponds escalated in direct correlation with their size. Specifically, the mean cost of constructing a pond spanning 100 m<sup>2</sup> amounted to K750, while a 200 m<sup>2</sup> pond incurred a cost of K1,500, and a 300-square-meter pond necessitated an outlay of K2,500. Given that the construction of ponds was reliant on hired labour, numerous farmers were precluded from owning a greater quantity of larger-sized ponds. Consequently, many farmers were compelled to choose between a limited number of larger fish ponds and smaller ones, thereby impeding their capacity to generate profits as a business.

**Estimate of the total number of active fish ponds in Chinsali and Shiwang'andu districts.**

In the Shiwang'andu district, it was observed that all the fish farmers whose ponds were subjected to sampling were still utilizing them. However, in the Chinsali district, a contrasting scenario was observed as a significant proportion of 88% of the fish farmers had operational fish ponds, as depicted in Figure 13.



Figures 13: The average number of active fish ponds per individual farmer in Chinsali district

The majority of farmers in both districts have encountered significant challenges in expanding their enterprises. These challenges include inadequate supply of fingerlings from the source, difficulty accessing loans from financial institutions, high costs of hired labour for pond construction, and the need to transport fish feed from distant locations due to the absence of a feed manufacturing plant in the two districts. Fakoya *et al.* (2001) emphasized the importance of capital as an essential tool for investment, which was necessary for the commercialization and amplification of aquaculture. Furthermore, Brummet (1995) noted that capital expenditures in fish farming tended to be relatively high and required long-term financing arrangements.

## The production levels of fish farming in the districts of Chinsali and Shiwang’andu

The results of the study indicate that, despite possessing ample land and sufficient access to water resources, fish farming in the Chinsali and Shiwang’andu districts of the province was only conducted on a small-scale, with only a handful of farmers operating as medium-scale producers. Furthermore, commercial operations were non-existent in these two districts. The absence of low or interest-free loans from financial institutions was cited as one of the reasons for this state of affairs. Even when loans were available, they were accompanied by stringent collateral requirements. This finding is consistent with the research conducted by Mwamuye *et al.* (2012), which demonstrated that the lack of resources to support the expansion of fish farming operations and a shortage of fingerlings across the country contributed to the absence of commercial fish farming in certain regions of Kenya.

### 3.11. The stocking densities of fingerlings in ponds of varying sizes located in the Chinsali and Shiwang’andu districts of the Muchinga province

In the Chinsali district, 38% of the fish farmers who were sampled stocked their ponds with 100-500 fingerlings on average pond areas of 100m<sup>2</sup>. Approximately 54% of the farmers stocked their ponds with 501-1000 fingerlings, while 8.33% stocked their ponds with 1001-2000 fingerlings.

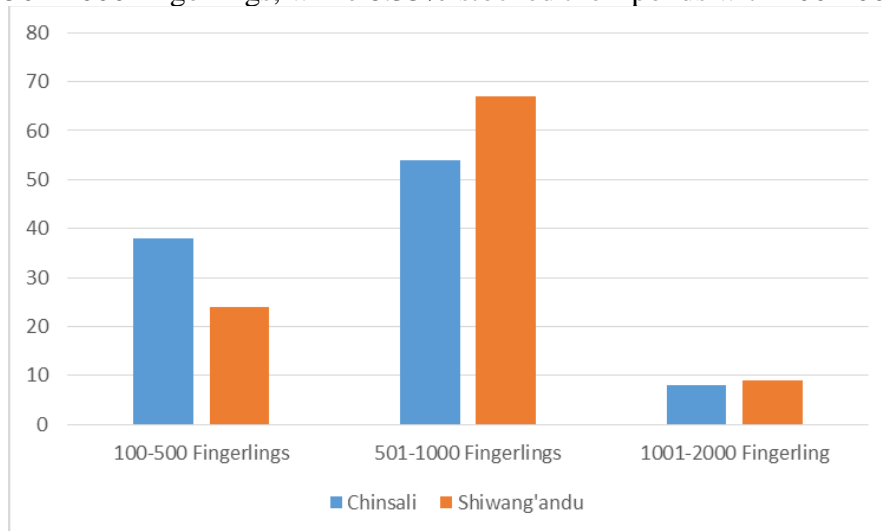


Figure 14: Fingerling stocking density in Chinsali and Shiwang’andu districts.

In Shiwang’andu, a significant proportion of farmers stocked their ponds with fingerlings. Specifically, 24% of farmers stocked between 100 and 500 fingerlings, 67% stocked between 501 and 1000 fingerlings, and 9% stocked between 1001 and 2000 fingerlings (as illustrated in Figure 14). Based on the study’s findings, it can be inferred that some fish farmers stocked their ponds with an average of 3 fish/m<sup>2</sup>, which is considered optimal for subsistence-level management. However, others stocked their ponds with 4 fish/m<sup>2</sup>, representing a slight increase of one fish per square meter. Mainza and Musuka (2015) reported that small-scale fish farmers in three districts of the Lusaka province stocked their ponds with 3 fish/m<sup>2</sup> to ensure subsistence-level management and protect the fish from heightened competition for natural food and oxygen.

### The cultivated fish species in the districts of Chinsali and Shiwang’andu, as well as the annual production cycles implemented by said farmers.

The prevalent fish species cultivated in the Chinsali and Shiwang’andu districts were *Coptodon rendalii*, *Oreochromis macrochir*, and to a certain extent, *Oreochromis andersonii*, which are indigenous to Zambia and can be found in almost every body of water in the country. The findings of the study revealed that *Coptodon rendalii* was the sole cultured fish species in the Shiwang’andu district. However, in Chinsali, 79% of the population cultivated *Coptodon rendalii*, 8% cultivated *Oreochromis tanganyicae*, and 13% cultivated *Oreochromis macrochir* (refer to Figure 15).

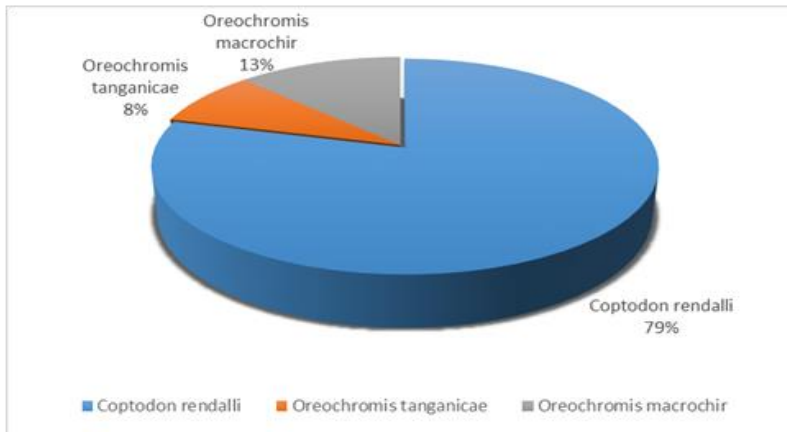


Figure 15: The commonly cultured species of fish in Chinsali and Shiwang'andu districts.

FAO (2006), documented that the Three-spotted bream (*Oreochromis andersonii*), the Green-headed bream (*Oreochromis macrochir*), and the Red-breasted bream (*Coptodon rendalii*) were the frequently utilized species in aquaculture.

Neither of the two districts had established fish hatcheries to facilitate the procurement of high-quality fish fingerlings. Those farmers who possessed the financial means obtained their fingerlings from either the Isoka government fish farm or from Misamfu in Northern Province, located in Kasama, at a cost ranging from K0.5 to K1. Misamfu was situated outside of Muchinga Province and was not easily accessible to many farmers.

The lack of access to superior quality fingerlings was identified as one of the common challenges faced by farmers. Consequently, many farmers resorted to understocking, leaving numerous ponds unstocked due to a shortage in the supply of fingerlings, or utilizing recycled seeds, which resulted in the cultivation of highly inbred fingerlings that reduced growth potential (Fig. 16).

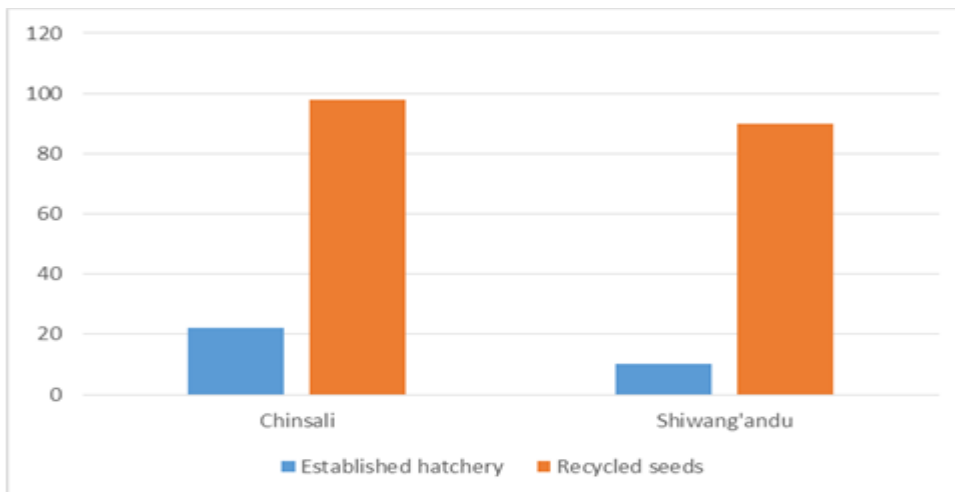
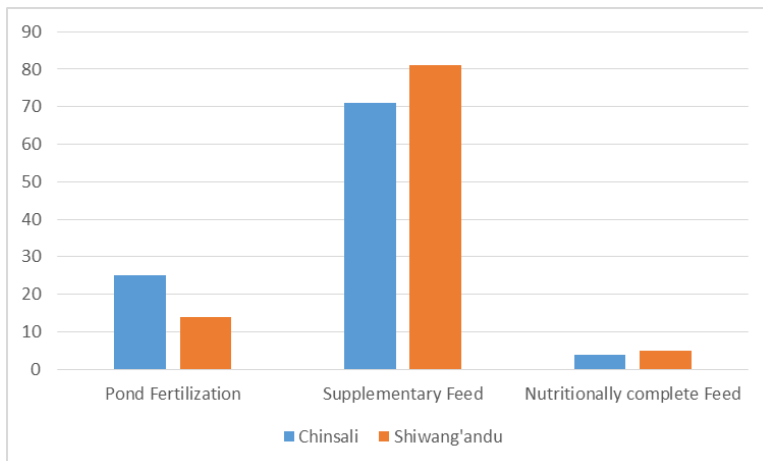


Figure 16: Profile Fish use by farmers.

### Grow out and mode of feeding the fish in Chinsali and Shiwang'andu districts.

In the Chinsali district, a quarter of the fish farmers who were sampled utilized broiler chicken manure as a means of fertilizing their ponds. However, a significant majority of 71% provided supplementary feeding to their fish, incorporating kitchen wastes, maize, and rice bran into the ponds. A mere 4% of the farmers were able to provide their fish with nutritionally complete feeds, as depicted in Figure 17. Conversely, in the Shiwang'andu district, only 5% of the sampled fish farmers were able to provide their fish with nutritionally

complete feeds, while 80% of them resorted to supplementing their fish’s diets, as illustrated in the same figure.



Figures 17: Mode of feeding the fish in Chinsali and Shiwang’andu districts.

The low productivity of ponds, resulting in a low yield of fish at harvest, was attributed to the continued use of low-quality feed. The majority of fish farmers claimed that they were unable to afford compounded fish feeds from commercial manufacturers outside of the province or from commercial retail outlets within Muchinga province due to high costs. Banda and Musuka (2020) found that many farmers in their study used feeds with only one ingredient, while only a small number claimed to be able to create compound feeds on their farms. Nsonga and Simbotwe’s (2014) study revealed that smallholder farmers in Zambia lacked access to commercially produced feed and fish seeds of certified quality, and when available, they were too expensive for them to afford.

The development of aquaculture in the two districts was hindered by a lack of access to high-quality commercial feed, in particular. Based on this study, many farmers used feed produced on their farms, with some using one-ingredient feeds due to insufficient funding to purchase all necessary equipment for a fish farming business. The installation of small and simple feed mills in designated locations to serve local farmers and accommodate local feed prices would greatly aid the development of aquaculture in the province.

### 3.14. Price per kilogram (kg) of pond raised fish in Chinsali and Shiwang’andu districts

The graphical representation depicted in Figure 18 illustrates the prevailing retail prices of fish in the two districts. It is noteworthy that approximately 8% of the fish farmers operating in the districts of Chinsali and Shiwang’andu have been observed to vend table-sized fish at a price exceeding ZMK40 per kilogram.

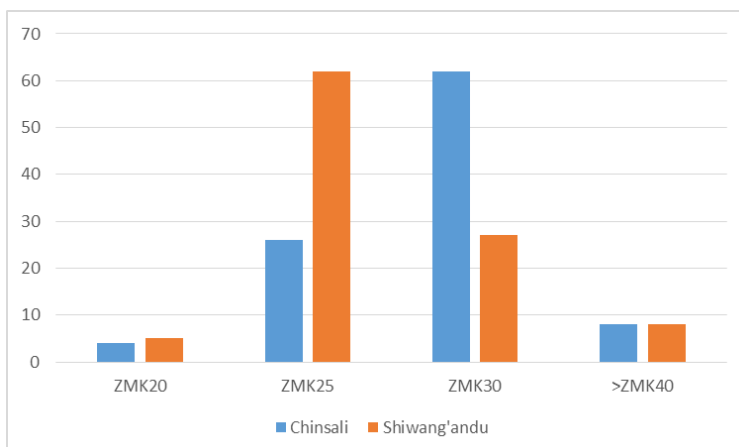


Figure 18: Retail Price of Table size fresh fish per Kg in Chinsali and Shiwang’andu districts

However, all of the fish cultivated in the Chinsali and Shiwang'andu districts were exclusively sold within the local vicinity, either at the primary markets or on the banks of the ponds. Owing to inadequate road infrastructure, certain fish farmers purportedly sold their yield at reduced prices locally, as they were unable to transport it to the primary market. As per Nandlal and Pickering (2004), fish farmers must comprehend their potential customers and, more importantly, identify their preferences in terms of quantity and quality of fish, as well as how and where they desire it to be available, and at what price the fish is to be purchased. Market research would be employed to achieve the aforementioned objectives.

### 3.15 The viability of fish farming for farmers in the districts of Chinsali and Shiwang'andu.

The study revealed that fish farmers held the belief that aquaculture, or fish farming, was a prosperous enterprise. As per Nandlal and Pickering's (2004) methodology, an enterprise budget was employed to ascertain the profitability of a business. If the total revenue generated from sales during a specific period exceeded the total costs incurred, the business was deemed profitable during that period (Nandlal and Pickering, 2004).

Based on the findings of this study, the majority of fish farmers in both districts asserted that they were capable of paying the requisite school fees for their school-going children. However, a few fish farmers had managed to utilize their business to construct homes, as depicted in Figure 19.

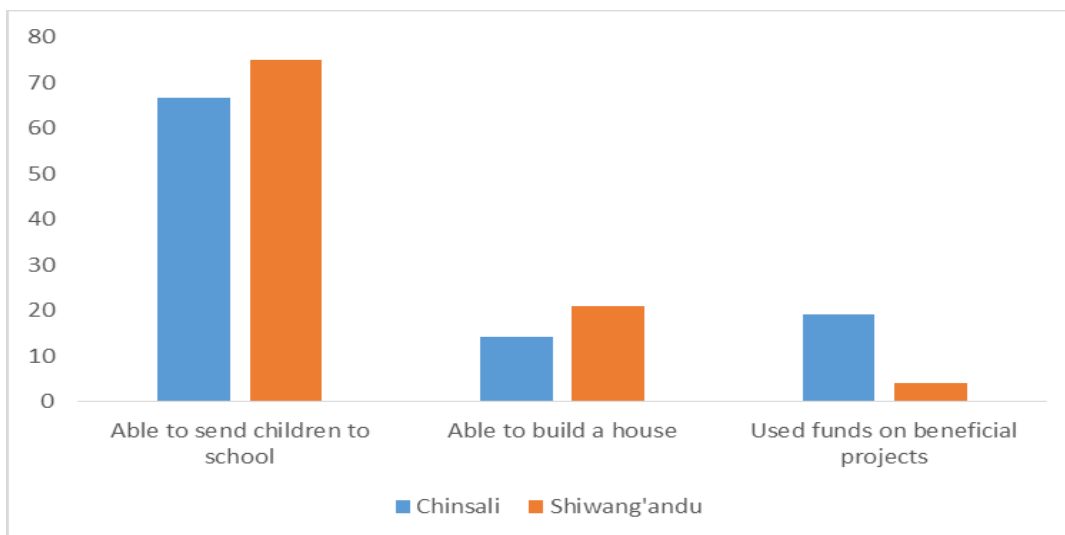


Figure 19: The profitability of fish farming to the farmers in Chinsali and Shiwang'andu districts

Farmers reported notable improvements in the availability of protein in their diets, as well as substantial financial gains resulting from the sale of their fish. The proceeds from these sales have also been utilized to meet other essential family needs. These observations are in line with the research conducted by Edwards (2000), which highlights the success of fish culture in enhancing the living standards of rural farmers in Asia, where it has a long-standing tradition. According to Hastein (2006), fish is a significant source of protein in the human diet, with over 30% of all fish consumed by humans originating from fish farming. These fish species are diverse in nature, as noted by Hetland (2008).

## CONCLUSION

The development of a thriving fish farming sector in the Chinsali and Shiwang'andu districts necessitates the collaborative efforts of all concerned parties. This includes the continual enhancement of fish farmers' capabilities through initiatives such as workshops focused on fish farming training. The poor performance of fish farmers in these two districts can be attributed to the absence of dependable sources for high-quality

seed and feed. The Department of Fisheries and other stakeholders have the potential to enhance their extension services and the ongoing training programs they provide to farmers. The lack of substantial investment in the project at a commercial scale level indicates that the nation has not fully capitalized on these resources within the province. Consequently, their returns on capital investments have been diminished.

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