International Journal of Humanities and Education Research

ISSN Print: 2664-9799
ISSN Online: 2664-9802
IJHER 2025; 7(1): 126-132
www.humanitiesjournal.net
Received: 05-11-2024
Accepted: 08-12-2024

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Examining fish production in improving household living conditions: A case study of fish farmers Kasama's Zone 5 Area

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DOI: https://doi.org/10.33545/26649799.2025.v7.i1b.144

Abstract
This study examines the impact of fish production on household living conditions in Kasama's Zone 5 Area. A survey of 50 fish farmers explored fish farming strategies, including fish types, feed, pond management and marketing. Results revealed 60% farm tilapia, favored for its growth and marketability and 30% farm catfish for its resilience. Commercial feed was the most used (50%), followed by homemade feed (30%), reflecting cost-conscious practices. Key pond management strategies included water quality testing (40%) and pond maintenance (30%), aimed at enhancing productivity. Local markets (60%) were the primary sales channel, underscoring the role of local demand. Socio-economic benefits included income increases (60%), job creation (90%), improved food security (70%), and school fee affordability (50%). A Chi-Square test showed a significant link between fish type and feed choice (P=0.032), but not between fish type and food security (P=0.192). Awareness of policies was high (70%), yet only 50% utilized them. A significant association between policy awareness and perceived effectiveness (P=0.000) highlights the need for improved communication and education. These findings offer valuable insights for policymakers to enhance fish farming and improve livelihoods in the region.

Keywords: Aquaculture, fish production, household income, socio-economic benefits, policy interventions

1. Introduction
This chapter will give an outline on the background of the study, its statement of the problem, the general objective and its specific objectives and the research questions. It will then look at the significance of the study and the conceptual framework.

1.1 Background
Countries in Africa have been touted for their high aquaculture potential based on land and water availability, ideal temperatures and animal husbandry and agricultural practices. Increased production of farmed fish could help improve the food and nutrition insecurity situation in many of these countries and contribute positively to overall economic growth (Beveridge *et al*. 2018) [4]. Despite the potential, the development of aquaculture in most African countries has been sluggish compared to other regions, mostly because of weak infrastructure, markets, government policies and a lack of knowledge and skills to build the sector (Brummet *et al*. 2008) [7]. The total share of global production is still only 2.3%, with production in Egypt making up the bulk of the total output. Recently, however, aquaculture production in sub-Saharan Africa has increased at an annual average growth rate of 12.6%, and there is evidence of commercial growth in certain countries such as Nigeria, Ghana, Uganda and Kenya.
Aquaculture adoption can have various positive impacts at different levels from farm and household to community and national levels, by contributing to food and nutrition status to people. It also helps to improve the purchasing power due to income generation from selling fish and create employment opportunities, which in turn significantly influence food demands and consumption (Kassam and Dorward, 2017) [14].

Zambia can learn countries such as Tanzania. Fish farming in Tanzania is dominated by fresh water rural pond fish farming with pond size of 150-300 m2 where O. niloticus is the dominant species followed by C. gariepinus (Kaliba, Osewe, Senkondo, Mnembuka, & Quagrainie, Citation 2006). Other fish species with potential for aquaculture include milkfish (*Chanos chanos*) and the mud crab (Scylla cerata) that could be cultured in brackish and marine waters. According to the National bureau of statistics, Tanzania was estimated to have 13,011 fish ponds by 2005. Estimates for 2016 stands at 22,542 fish ponds engaging some 18,900 fish farmers with a total production of 3,840 metric tons per year valued at TZS 22,000 million in 2016 (National Bureau of Statistics [NBS], 2018).

In 2017, the African Development Bank (AfDB) approved a loan for the Zambian government to implement the Zambia Aquaculture Enterprise Development Project (ZAEDP) to present the aquaculture subsector as a viable and inclusive business opportunity for small-to medium-sized farmers and enhance production and productivity for improved livelihoods along the aquaculture value chain. From an economic perspective, increased uptake of aquaculture by small-scale farmers could help increase per capita income, diversify livelihoods and combat poverty, as seen in the case of Ghana (Kassam and Dorward 2017) [14]. This is of critical importance given that in 2015, 54.4% of the population lived below the poverty line (76.6% in rural areas and 23.4% in urban areas) and 40.8% of people were considered extremely poor (CSO, 2016).

1.2 Statement of the problem

Despite its introduction over past the 50 years, aquaculture production in Zambia has only increased slowly. Some reasons to this are a lack of enabling policies, techno-knowhow, credits, and high cost of imports and production. In response to this situation, a number of solutions such as development of suitable production systems, availability and accessibility of good quality seeds and feeds and more appropriate research and extension are proposed. Furthermore, the contribution of rural small scale fish farming to farmers' livelihood and household income in particular is little known in Zambia. Understating factors associated with income from fish farming and the degree to which it contributes to the farmers' household income diversification, would be a good entry point toward more appropriate aquaculture promotion interventions, which in turn could help increase aquaculture adoption rates and production.

1.3 General objective

The aim of the study is to examine fish production in improving household living conditions: A case study of fish farmers Kasama's Zone 5 Area.

1.4 Specific objectives

- To establish fish production strategies used by small scale farmers in Kasama's Zone 5 area.
- To analyze the socio-economic benefits of fish production at house hold level.
- To analyze effectiveness of policy interventions meant to improve fish.

1.6 Significance of the study

The study aims to guide the Zambian government in formulating policies to revitalize fish production and engage stakeholders in food security initiatives. It seeks to equip agricultural extension personnel with insights to enhance their effectiveness and design capacity-building programs for small-scale farmers. While aquaculture impacts ecosystems through land transformation and pollution, it also improves livelihoods by diversifying income sources and providing essential nutrients. It serves as a sustainable alternative to resource-intensive terrestrial animal production, such as beef feedlots.

Balancing aquaculture's ecological and socioeconomic consequences is crucial. Modern approaches manage landscapes and seascapes for multiple functions beyond food production, requiring the integration of ecological research, policy innovation, and public education. The FAO's "Ecosystem Approach to Aquaculture" offers a framework for sustainable development, equity, and resilience by aligning aquaculture with ecosystem functioning. This approach encourages institutional collaboration and a deeper understanding of ecosystems to foster sustainable aquaculture practices.

1.7 Conceptual Framework

The study highlights the dual impact of aquaculture on ecosystems and livelihoods. While aquaculture can degrade ecosystems through land transformation and pollution, it also provides significant benefits by enhancing food production and diversifying livelihoods. This duality presents a challenge: balancing aquaculture's negative ecological impacts with its positive contributions to food security and economic welfare.

Aquaculture has proven to be a sustainable alternative to resource-intensive livestock systems like beef production, offering a reliable source of protein, micronutrients, and lipids. However, its expansion requires careful management to mitigate ecosystem damage while maximizing benefits. Modern strategies, such as the FAO's "Ecosystem Approach to Aquaculture," emphasize sustainable integration of aquaculture into ecosystems. This approach promotes development that supports equity, resilience, and sustainability while fostering a deeper understanding of ecosystem functions.

To achieve this balance, coordinated efforts are essential. Policymakers, researchers, and the public must work together to integrate ecological and socioeconomic perspectives, encourage innovation, and improve education. Managing landscapes and seascapes for multiple functions-beyond food production-will be critical to ensuring aquaculture supports both human livelihoods and environmental health, providing a path toward more sustainable development.

2. Literature Review

2.1 Overview

This chapter reviews the literature from various sources to let the researcher know what others have done about the proposed research topic. The researcher will be able to identify the existing knowledge gap by reviewing various literatures. Small-scale fish farming is a vital component of rural livelihoods and food security in many developing countries, including Zambia. Various strategies are employed by small-scale fish farmers to enhance productivity and sustainability. This literature review explores the key strategies used by small-scale farmers in fish production, focusing on practices in Sub-Saharan Africa with specific insights applicable to the Kasama's Zone 5

area in Zambia. The chapter, therefore, reviews literature from the global perspective, the African perspective, and then trickles down to the Zambian perspective.

Fish production is a vital component of global food security and economic stability. According to the Food and Agriculture Organization (FAO), fisheries and aquaculture provide livelihoods for approximately 59.5 million people worldwide, the majority of whom are in developing countries (FAO, 2020). Fish is an essential source of animal protein and micronutrients, particularly in regions where other protein sources are scarce or expensive (Beveridge *et al*., 2013) [4].

Fish farming plays a crucial role in enhancing food security and nutritional outcomes. Fish is a rich source of essential nutrients, including omega-3 fatty acids, vitamins, and minerals, which are vital for human health (Beveridge *et al*., 2013) [4]. In many developing countries, fish is the primary source of animal protein, and increasing fish production can help address malnutrition and micronutrient deficiencies (Kawarazuka and Béné, 2011) [15].

Sustainability in aquaculture is critical for maintaining the long-term viability of fish farming and protecting natural ecosystems. Bostock *et al*. (2010) [6] highlight the importance of adopting sustainable practices, such as efficient feed use, waste management, and disease control, to minimize environmental impacts. Technological advancements and best management practices can enhance the sustainability and productivity of aquaculture operations. Effective policy and institutional support are crucial for the sustainable development of aquaculture in Africa. Hishamunda and Ridler (2006) [12] emphasize the need for governments to provide conducive policy environments, including subsidies, access to finance, and investment in research and development. Regional cooperation and the sharing of best practices can also enhance the sector's growth.

Aquaculture profitability is commonly measured through an analysis of the costs and revenues of the enterprise and Hatch and Engle (1987) used financial analytical techniques to show that Panama‘s resource-limited farmers benefited from the adoption of fish farming..

Other authors have identified education and training as contributors to the growth and success of small enterprises (Simpson *et al*., 2004; Kolstad and Wiig, 2013) [23, 16]. David L Ortega (2012) [20] Consumers are increasingly aware of the quality and safety of the aquaculture products they consume. As dynamic demand from consumers requires changes in the production and marketing of aquaculture products, suppliers are faced with decisions regarding the adoption or discontinuation of various practices regarding the production and marketing of their aquaculture products. Midwest aquaculture producers and retailers face difficult supply management and food safety decisions partially due to significant uncertainty regarding American consumers ‘WTP for various food product informational attributes.

Ngugi *et al* (2007) [18] similarly observed the same challenges as a stumbling block towards commercial fish farming in Kenya. Ngugi *et al* (2007) [18] found that the number of productive ponds declined in the 1980s, mainly because of inadequate extension services, lack of quality fingerlings, and insufficient training for extension workers. Until the mid-1990s, fish farming in Kenya followed a pattern similar to that observed in many African countries, characterized by small ponds, subsistence-level management, and very low levels of production.

2.2 Personal critique of the literature review

The knowledge gap that is going to be addressed in this study is that despite the fact that the government‘s effort to improve fish production in Zambia’s economy, boost the nutritional situation of the farmers and create employment (TISA, 2010) by funding Fish pond construction costs as well as the costs for feeds and fingerlings being subsidized by the programme, governmental infrastructure supporting the aquaculture sub-sector, i.e. trainings, research farms and extension officers, Zambia’s aquaculture production is still insignificant has also observed inadequate technical skills by extension staff occasioned by low staff levels with limited practical aquaculture skills as the main constraint to commercial aquaculture. Ngugi *et al* (2007) [18] similarly observed the same challenges as a stumbling block towards commercial fish farming. Ngugi *et al* (2007) [18] found that the number of productive ponds declined in the 1980s, mainly because of inadequate extension services, lack of quality fingerlings, and insufficient training for extension workers. MEd well journals (2010) research aims to determine the socio-economic factors around fish farming. According to the results of the analysis, the most effective factors on fish consumption can be stated as price and dietary attributes. Therefore, it is concluded that by setting the market price of fish in line with different household income levels, dietary habits might change as well which can create a gap in fish production amongst small scale farmers. 24 Inadequate entrepreneurship skills by the farmers and lack of credit accessibility constraining production and growth on small scale fish farmers despite of community self-help groups providing services where the government might have failed.

3. Research Methodology

This chapter outlines the methodologies used in the research study on fish farmers in Kasama's Zone 5 area. Adopting a descriptive research design, the study aimed to analyze existing phenomena by collecting raw data through scientific methods. A total of 50 fish farmers were selected using judgmental sampling, a non-probability method chosen due to time and financial constraints.

Data collection incorporated both primary and secondary sources, including self-administered questionnaires, personal and telephonic interviews, observations, and reviews of documents like manuals and annual reports. Questionnaires enabled the researcher to reach a larger audience, while unstructured interviews provided deeper insights through respondents' expressions and gestures. Data were analyzed using Microsoft Excel, with thorough checks for omissions and consistency before coding. Descriptive statistics were employed, and findings were presented in charts and tables.

To enhance credibility and validity, triangulation was utilized by cross-verifying findings through multiple methods. Reliability and validity were ensured by replicating the questionnaires elsewhere and comparing results. The study faced limitations such as limited access to some farmers due to geographical and communication barriers, as well as budget and time constraints. Ethical considerations were prioritized by protecting respondents' privacy, not collecting personal identifiers, and ensuring

voluntary participation with the option to withdraw at any time.

4. Research Findings and Discussions

4.1 Presentation of Results on Background Characteristics of the Respondents

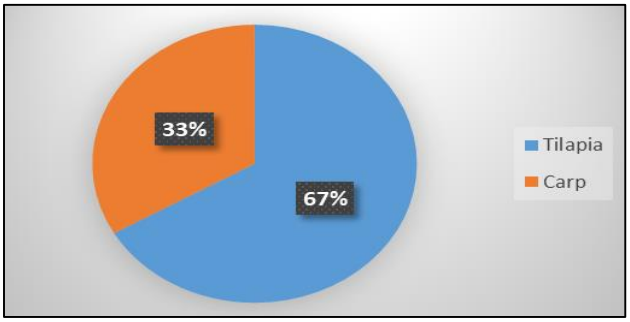

Fig 1: Gender (Sex)

The gender as shown in figure above indicates that the percentage of males' fish farmers was high which accounted for (70.0%) and females who accounted for (30.0) respectively.

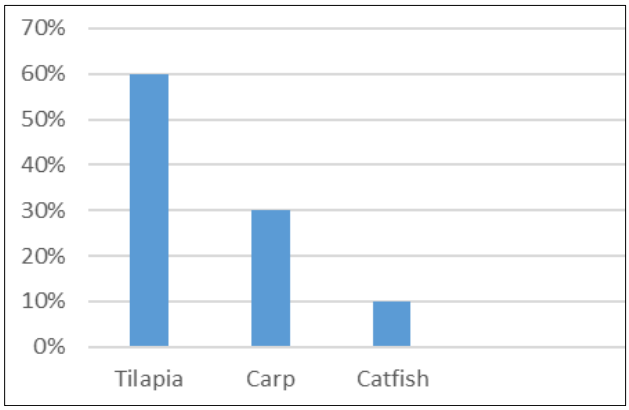

Fig 2: Age

The bar graph illustrates the gender distribution of fish farmers across different age groups in Kasama's Zone 5 Area. The graph shows that Age Group 18-25: There are 10 fish farmers, with 8 males and 2 females, indicating a 4:1 male-to-female ratio. Age Group 26-35: This group has the highest number of fish farmers (30), with 20 males and 10 females, showing a 2:1 male-to-female ratio. Age Group 36-45: There are 25 fish farmers, with 15 males and 10 females, maintaining a 3:2 male-to-female ratio. Age Group 46-55: This group includes 20 fish farmers, with 15 males and 5 females, reflecting a 3:1 male-to-female ratio. Age Group 56+: There are 15 fish farmers, with 10 males and 5 females, also showing a 2:1 male-to-female ratio. This data suggests that fish farming in Kasama's Zone 5 Area is predominantly managed by males, especially in the prime working ages of 26-45.

The pie chart illustrates the distribution of education levels among fish farmers in Kasama's Zone 5 Area. A small minority of 1 fish farmer (0.3%) have no formal education. 3 fish farmers (5.6%) have completed primary education. The largest groups, consisting of 28 fish farmers (56.6%), have completed secondary education. A significant proportion of 18 fish farmers (37.4%) have attained tertiary education.

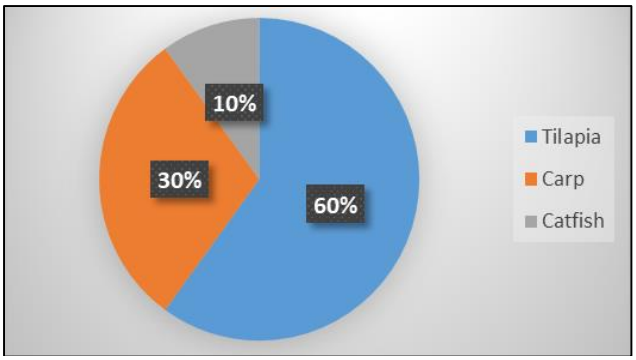

Fig 3: Educational Level

4.2 Presentation of results based on a thematic area developed from objective one

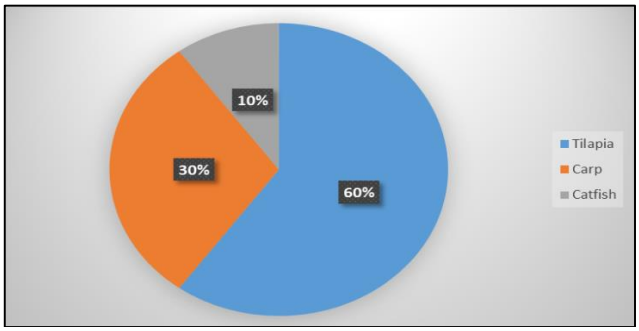

Fig 3: Types of Fish Farmed

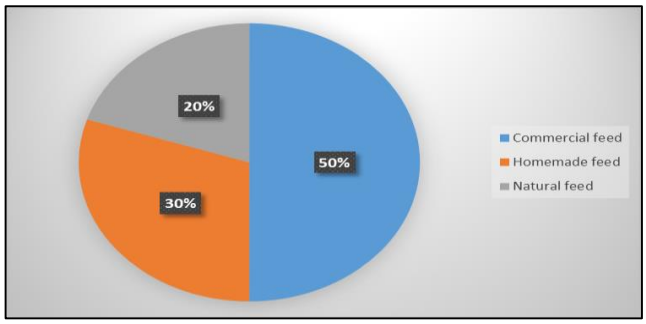

Fig 4: Type of Feed

Table 1: Pond Management Practices

Pond management	No of Farmer	Percentage
Regular water quality testing	20	40%
Periodic pond maintenance	15	30%
Use of Aerators	10	20%
Natural pond management	5	10%
Total	50	100%

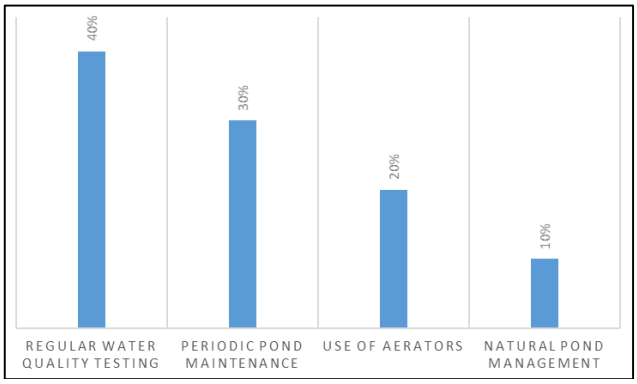

Fig 5: Pond Management Practices

Table 2: Marketing Techniques

Marketing techniques	No of farmers	Percent
Local markets	30	60%
Direct to consumers	10	20%
Wholesale to retailers	7	14%
Online sales	3	6%
Total	50	100%

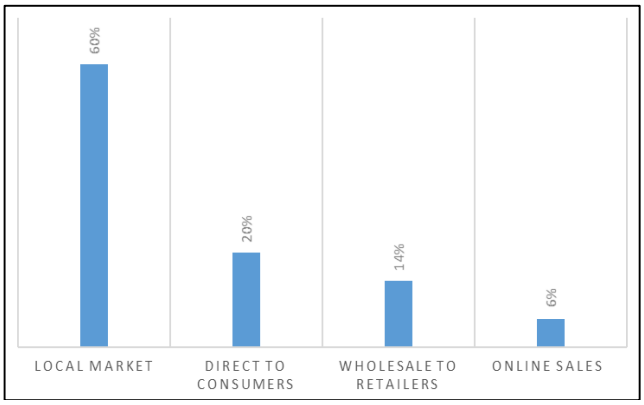

Fig 6: Marketing Techniques

A Chi-Square Test of Independence was conducted to determine if there is a significant association between the type of fish farmed and the type of feed used.
A chi-square test was conducted to determine if there was a relationship between the type of fish farmed and the type of feed used. Since the p-value (0.032) is less than the significance level (0.05), we reject the null hypothesis and conclude that there is a significant association between the type of fish farmed and the type of feed used.

4.3 Presentation of results based on a thematic area developed from objective two

4.3.1 Identification of socio-economic benefits of fish production

A sample of 50 fish farmers from Kasama's Zone 5 Area was surveyed to understand the socio-economic benefits derived from fish production. The key areas of focus included income generation, employment creation, food security, and education improvement. The data were analyzed using descriptive statistics, and relevant pie charts and bar graphs were created to visualize the findings.

Table 3: Table cross-tabulation chi-square test of independence

Income generation	Frequency	Percent
Increased household income	30	60%
No significant change	5	10%
Stable income	15	30%
Total	50	100%

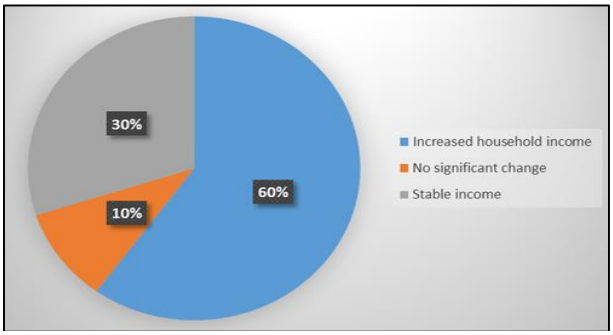

Fig 7: Income Generation

Employment creation	Percent
Full time jobs created	40%
Part-time jobs created	50%
No jobs created	10%
Total	100%

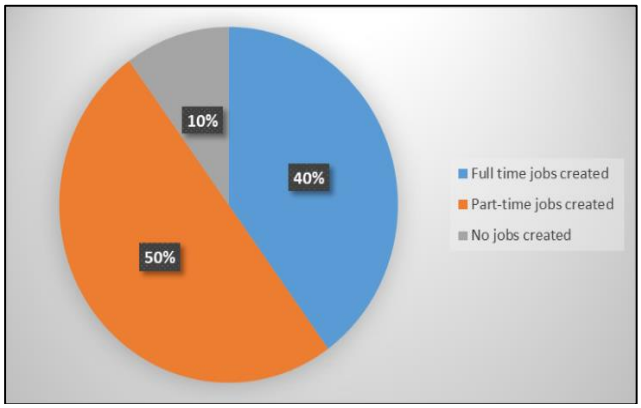

Fig 7: Employment Creation

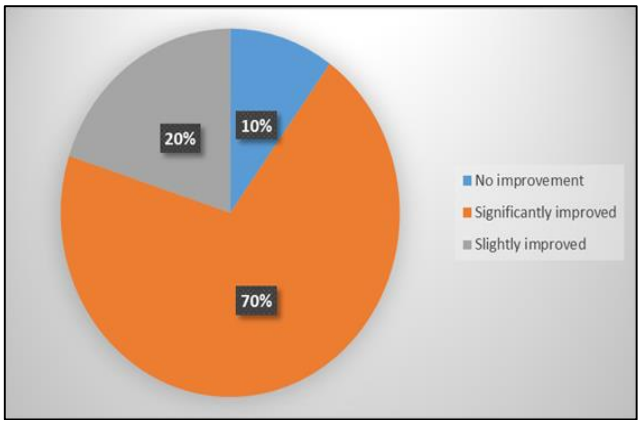

Fig 8: Food Security

Table 4: Education Improvement

Education improvement	Frequency	Percent
Able to afford school fees	25	50%
Able to afford school supplies	20	40%
No improvement	5	10%
Total	50	100%

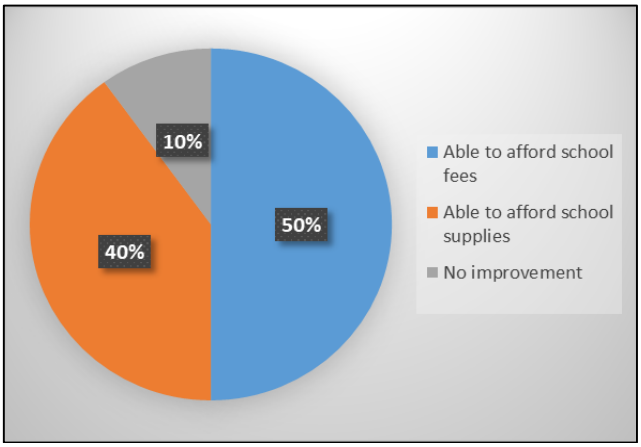

Fig 9: Education Improvement

4.3.2 Cross-Tabulation Chi-Square Test of Independence

To further analyze the association between fish production and these socio-economic benefits, a Chi-Square Test of

Independence was conducted. The test was applied to the relationship between the type of fish farmed and the improvement in food security.

Interpretation

The Chi-Square test result shows a p-value of 0.192, which is greater than the significance level of 0.05. Therefore, we fail to reject the null hypothesis and conclude that there is no significant association between the type of fish farmed and the improvement in food security.

This result suggests that the type of fish farmed by households in Kasama's Zone 5 Area does not have a significant impact on the level of improvement in food security. This comprehensive analysis highlights the various socio-economic benefits of fish production among households in Kasama's Zone 5 Area, demonstrating the positive impacts on income, employment, food security, and education. While most of the benefits show significant improvements, further research could explore other factors influencing these outcomes.

Policy interventions	Frequency	Percent
Aware	35	70%
Unware	15	30%
Total	50	100%

4.4 Presentation of results based on a thematic area developed from objective three

4.4.1 Analysis of the effectiveness of policy

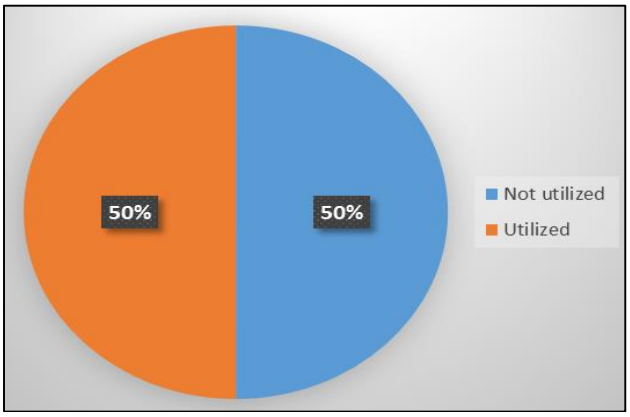

Fig 10: Utilization of Policy Interventions

4.4.2 Perceived Effectiveness of Policy Interventions

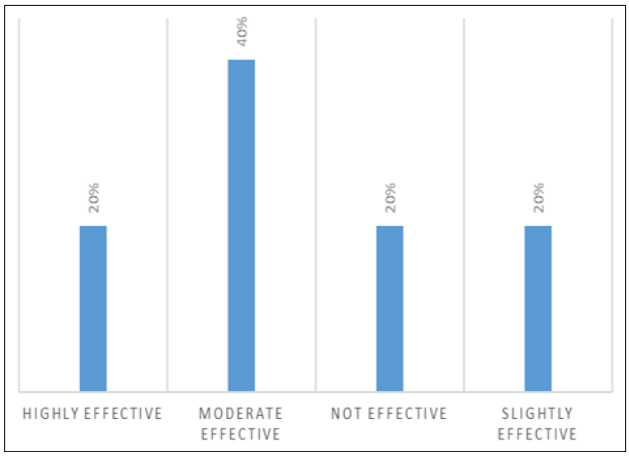

Fig 11: Perceived Effectiveness of Policy Interventions

Table 5: Effectiveness of Policy Interventions

Effectiveness	Frequency	Percent
Highly effective	10	20%
Moderate effective	20	40%
Not effective	10	20%
Slightly effective	10	20%
Total	50	100%

4.4.4 Cross-Tabulation: Awareness vs. Effectiveness

To determine if there is a significant association between awareness of policy interventions and their perceived effectiveness.

4.5 Discussion of Research Findings

This section discusses the findings on fish farming in Kasama's Zone 5 area, focusing on fish production strategies, feed types, pond management practices, marketing techniques, socio-economic impacts, and policy interventions. The discussion aims to contextualize these findings, providing insights into patterns and implications for improving fish farming in the region.

The majority of farmers (60%) prefer Tilapia due to its adaptability, fast growth, and high market demand, while 30% farm Catfish, valued for its resilience and disease resistance. Carp farming is the least common (10%), reflecting its demanding management needs and slower growth. Feed choice aligns with fish species, with 50% of farmers using commercial feed for its superior nutrition and growth benefits, while 30% opt for cost-effective homemade feed. The remaining 20% rely on natural feed, which is cost-saving but less reliable. Promoting affordable, high-quality feed options and educating farmers on feed formulation can address productivity challenges.

Pond management practices vary, with 40% conducting regular water quality testing and 30% engaging in periodic maintenance. Aerators are used by 20%, while 10% rely on natural pond management, highlighting resource and knowledge disparities. Most farmers (60%) market through local channels, emphasizing accessibility, while 20% sell directly to consumers. The limited adoption of wholesale (7%) and online sales (6%) indicates untapped potential. Providing training on modern marketing techniques and improving access to resources like aerators and testing kits could enhance farm sustainability and market reach.

Fish farming has significantly improved household income (60%) and food security (70%) while generating employment opportunities (90%). However, challenges such as high input costs and limited market access persist. Awareness of policy interventions is high (70%), but only 50% utilize them, reflecting barriers like accessibility and relevance. A significant link between policy awareness and perceived effectiveness (P=0.000) underscores the importance of effective communication and tailored support to enhance policy uptake and impact. Expanding outreach and simplifying application processes can further strengthen farmers' engagement with policy initiatives.

5. Conclusion and Recommendations

5.1 Conclusion

The findings reveal a promising yet challenging landscape for fish farming in Kasama's Zone 5 area. While there is significant potential for growth and socio-economic benefits, addressing challenges such as high feed costs, lack of fingerlings, and theft is crucial. The Fisheries Department's support through training, loans, and policy interventions has been beneficial, but further efforts are

needed to enhance awareness, utilization, and effectiveness. The socio-economic benefits, particularly in income generation, employment creation, food security, and education, underscore the transformative potential of fish farming for households and the broader community. Future directions should focus on improving pond management practices, marketing techniques, and incorporating new technologies to support sustainable and profitable fish farming in the region.

5.2 Recommendation

Based on the findings and discussions in Chapter 4 and 5 the following recommendations are proposed:

- Implement subsidies for commercial feed or support local production of feed ingredients to reduce costs for farmers.
- Provide training programs on producing homemade feed using locally available resources to ensure nutritional adequacy while lowering costs.
- Encourage the establishment of local hatcheries through grants and loans to ensure a steady supply of fingerlings.
- Implement quality control measures to ensure the fingerlings are healthy and of high quality.
- Encourage the formation of community watch programs to prevent theft and predation.
- Promote the use of affordable security technologies such as surveillance cameras and alarms.
- Conduct targeted information campaigns to raise awareness about available policy interventions and how to utilize them.
- Establish robust feedback mechanisms to understand farmers' challenges and improve the relevance and effectiveness of policies.
- Facilitate access to microloans and grants to help farmers expand their operations and generate more income.
- Develop programs that create full-time and part-time employment opportunities within the fish farming value chain.
- Ensure long-term support for fish farmers through continuous training, financial assistance, and policy interventions.

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