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Freshwater Aquaculture and Household Performance in Busia County, Kenya

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ABSTRACT

Aquaculture has become a household source of proteins, taking over the traditional red meat delicacy that promotes food security and livelihood for over 2.5 billion people. This covers approximately 40 percent of the world's fish production. As the population increases, the demand for fish increases owing to the current deficit. Therefore, the need for freshwater aquaculture is high to meet global demand. Busia County has benefited from internal and external support for household aquaculture practices to address nutrition challenges and livelihoods as well. This study investigated freshwater aquaculture performance in Busia County, Kenya. The study adopted a descriptive cross-sectional research design, applying both quantitative and qualitative methods. The target population was 55,608 households in Bunyala and Teso South sub-counties, resulting in a sample size of 384 households. Simple random sampling was used to select the households, while purposive sampling was used to select key informants. Questionnaires, interview schedules, focus group discussion guides, and photography were used to collect data. Quantitative data were analyzed using SPSS version 25.0, while qualitative data was analyzed by grouping them into themes and reporting verbatim. Private hatcheries produced the majority of fingerlings, which increased their price for households. Households bought fish feed from the local agrovets, which was not quite affordable to farmers. Extension services were primarily provided in pond management (96.1%; OR = 2.67), record-keeping (92.7%), and fish marketing (77.7%). Private sector hatcheries are the main distributors of fingerlings to farmers, which could have contributed to the higher price of a fingerling while also considering the transportation cost of the precious fingerlings. Pond management, recording keeping, and marketing were the main extension services accorded to households surveyed. Owing to the low investment in hatcheries by the national and county governments of Busia, there is a need to rethink the installation of government hatcheries in all sub-counties for ease of accessibility and affordability in order to promote the sustainability of aquaculture.

Keywords: Aquaculture, Busia County, Extension Services, Fingerlings, Freshwater Aquaculture

I. INTRODUCTION

Aquaculture has enhanced food security for over 2.5 billion people, generated sources of livelihood for approximately 530 million people, and contributed approximately 40 percent of the world's fish production (Carter, 2018). Developed countries such as the United States of America (USA) have strong laws that protect fish farming and fisheries, which is not the norm globally (Fry et al., 2014). Ninety percent of fish farming produces thirty percent of the world's fish supply, which has been attributed to the advancement of fish farming technologies (Kobayashi et al., 2015). The global decline of wild fish stocks has led to the introduction of freshwater aquaculture, which has potential for sustainability and scalability (Chen and Qiu, 2014; Hossain, 2014; Ateweberhan et al., 2018).

Large-scale aquaculture in Africa has been on the decline despite the vast aquatic resources that flourish on the continent (Ababouch and Fipi, 2015). Capture fisheries, especially oceans, have dwindled, inviting investment in

freshwater aquaculture. Thus, there has been an increasing dependency on freshwater aquaculture due to declining capture fisheries (Mathiesen, 2015). Freshwater aquaculture has played a vital role in contributing to food security, especially by providing primary sources of animal protein, essential nutrients, and income (Béné et al., 2016). Challenges faced by households practicing freshwater aquaculture are caused by poor pond management, unreliable sources of fish fingerlings, poor quality and accessibility of fish feed, and aquaculture sustainability issues (Shitote et al., 2012; Soliman and Yacout, 2016; Asiedu et al., 2017). Aquaculture activities such as processing and value addition in Africa are still underdeveloped.

Fish farming in Kenya began in the 1920s with tilapia species and later saw the introduction of the common carp and African catfish (Munguti et al., 2014). Furthermore, Munguti et al. (2014) noted that tilapia and African catfish are the most commonly farmed fish in Kenya (tilapia accounting for 75% and African catfish for 21% of production). Other species include common carp, rainbow trout, koi carp, and goldfish. According to Musyoka and Mutia (2016), the government of Kenya invested USD 215 million (2019 May conversion rate) into the promotion of aquaculture production through the Economic Stimulus Programme (ESP) for the period 2009–2013. However, the current trend of fish farming in western Kenya has remained underdeveloped, with very low productivity in aquaculture. This venture is inherently faced with issues of expensive low-quality feeds, predation, inadequate and low-quality fingerlings, high costs of investment, pond siltation, and poor pond maintenance (Shitote et al., 2012).

Busia County had a poverty index of 64.2% in 2012 as compared to the national poverty index of 45.9%, which was attributed to food insecurity and was ranked the eighth-most food-insecure county in Kenya (WFP, 2016). Additionally, Soree (2017) acknowledges that Busia County experienced a limited or lack of extension service provision for most small-scale fish farmers. Small-scale fish farmers face many challenges, such as expensive, low-quality feeds and fingerlings affecting freshwater aquaculture performance in Busia County (Shitote et al., 2012). According to Kundu et al. (2016), the government policy on fish farming does not emphasize the importance of the provision of extension services to enhance the quality of fish. Western Kenya has only one government institution that produces reliable quality seed (Wakhungu Fish Farm at Bumala in Busia County, Kenya), which cannot sustain all fish farmers in Busia County and neighboring counties.

1.1 Statement of the Problem

Busia County is one of the counties around Lake Victoria, a freshwater lake, whose residents practice fishing as their main source of livelihood. There is a high demand for fish for subsistence consumption and commercial purposes. Moreover, owing to inadequate employment opportunities in Kenya, Busia residents opted to venture into freshwater aquaculture as their alternative livelihood and source of animal protein. Busia County has received massive investment in the promotion of freshwater aquaculture through pond construction and caged aquaculture in Lake Victoria (Odende et al., 2022). Notwithstanding, there have been challenges with the sustainability of freshwater aquaculture. Moreover, despite the County Government of Busia investing an estimated Kes 600 million (US$ 4.87 million), freshwater aquaculture trails behind (KNBS, 2019 July). Some farms produce fish fingerlings, fish feeds, or both; however, access to quality fish fingerlings, quality fish feed, and extension services is a challenge that lingers in Busia County. This study sought to assess the influence of freshwater aquaculture on household performance in Busia County, Kenya. This study was thus guided by the following research question: “What is the extent of freshwater aquaculture on household performance in Busia County?”

II. LITERATURE REVIEW

The world is experiencing increasing demand for fish products, while the sector has faced numerous challenges in capturing fisheries due to stagnation (Ertör and Ortega-Cerdà, 2015). The Food and Agricultural Organization (FAO) postulates that the future of global fish supply lies in aquaculture, which currently accounts for almost half of the world's fish food production and is projected to contribute more than 60 percent of fish for human consumption by 2030 (FAO, 2014; Mathiesen, 2015; Engle, Quagrainie, and Dey, 2016). According to the Organisation for Economic Co-operation and Development (OECD), fisheries and aquaculture products globally support the livelihoods of more than 530 million people (OECD, 2014). Aquaculture has been increasing at a significant rate of 6.2 percent since the year 2000, with Asia accounting for the bulk of global production (Bacher, 2015).

The aquaculture sector is tremendously stimulating the development of rural communities' livelihood opportunities for the rural poor by addressing social and economic issues: poverty, employment, and food security (Béné *et al*., 2015). In Peru, the freshwater aquaculture of trout (Oncorhynchus mykiss), tilapia (*Oreochromis niloticus),* and black pacu (*Colossoma macropomum*) is maximizing household socio-economic performance for the Peruvian population (Avadí and Fréon, 2015). However, the freshwater aquaculture sector is experiencing an increasingly difficult expansion.

Aquaculture development and growth in Africa have been declining despite the vast aquatic resources that flourish on the continent (Ababouch and Fipi, 2015). Since the introduction of aquaculture to Africa, there have been a lot of innovations, technological advancements, and progress in the areas of genetics, seed propagation, pond construction, and farm management in general (Koge et al., 2018). However, many political, economic, and technical issues are obstructing the development and promotion of aquaculture in Africa (Ababouch and Fipi, 2015).

Concerning sampled African countries in aquaculture, Egypt, as a desert country, has a long history of aquaculture and is the leading producer, especially of freshwater aquaculture, in Africa (Soliman and Yacout, 2016). Additionally, aquaculture in Egypt is considered the only viable option for reducing the current gap between the production and consumption of fish. Aquaculture practices in Ghana are intensive at both small-scale (pond) and large-scale (cage), with tilapia species (Oreochromisniloticus) accounting for 90 percent of fish farmed and African catfish (Clariasgariepinus) (Kassam, 2014). The studies stipulate that the main challenges experienced by African countries in freshwater aquaculture include poor pond management, resource use conflicts (water and land), unreliable sources of fish fingerlings, poor quality and accessibility of fish feed, and aquaculture sustainability issues (Soliman and Yacout, 2016; Asiedu et al., 2017).

Kenya is endowed with a vast network of aquatic resources comprising freshwater lakes and rivers and an extensive ocean resource base (Opiyo et al., 2018). The fisheries and aquaculture sectors contribute about 0.8 percent to the Gross Domestic Product (GDP), providing important livelihood opportunities for the rural poor by improving the local economy as well as supplementing protein sources (Kundu et al., 2016). Kenya's Vision 2030, together with other policy frameworks, recognizes aquaculture (fish farming) as a source of food security, poverty reduction, and employment creation (Ogello and Munguti, 2016). Freshwater fish account for close to 98 percent of Kenya's reported aquaculture production and are ranked as the fourth major producer of aquaculture in Africa. The study conducted by the Government of Kenya noted that the Western Kenya region records some of the highest rates of poverty and malnutrition; however, the region has a high potential for aquaculture development (Munguti et al., 2014). However, the freshwater aquaculture sub-sector has seen a decline in performance, with total fish output dropping by 19.8 percent from 18.7 metric tons in 2015 to 14,952 metric tons in 2016 (Opiyo et al., 2018).

2.1 A Basic Aquaculture Value Chain

The aquaculture extension in Africa focuses on the knowledge and skills required to grow fish. Husbandry techniques and some on-farm processing to reduce spoilage or add value are the main focus with some exposure to hatchery techniques. However, sustainable aquaculture development policy objectives call for the linkage between production and markets. Appropriate extension services tailored to the capacity needs of the various actors along the emerging aquaculture production-market value chains, therefore, become indispensable (Figure 1).

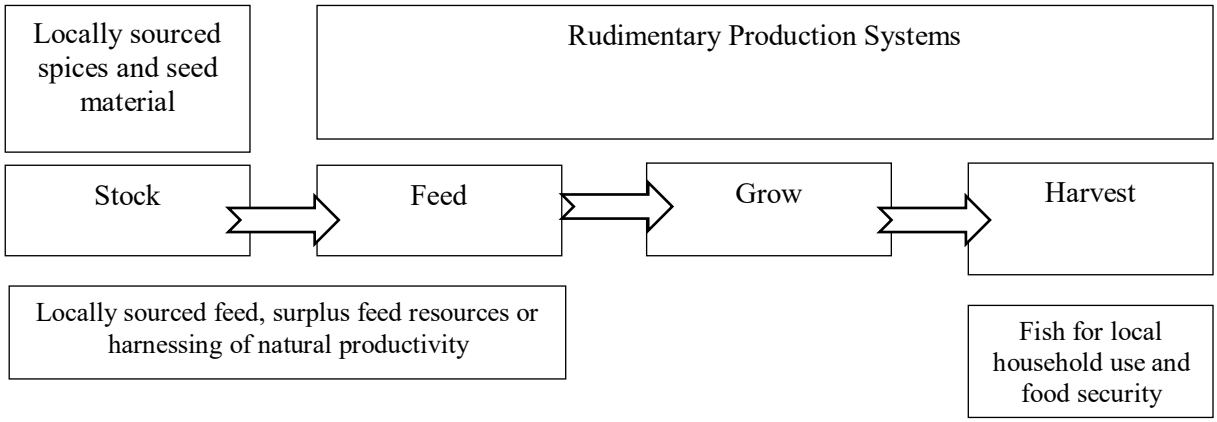

Figure 1

A Basic Aquaculture Value Chain Model For Freshwater Aquaculture and Household Socio-Economic Performance in Busia County, Kenya

II. METHODOLOGY

Busia County was selected as the study site. Busia County is situated in western Kenya, bordering Bungoma County to the north, Kakamega County to the east, Siaya County to the south-east, Lake Victoria to the south-west, and the Republic of Uganda to the west. Busia County headquarters are in Busia Town, which covers an estimated area of 1,695.3 square kilometers. The descriptive cross-sectional research design was used to study freshwater aquaculture performance in Busia County. The target population was the households in Bunyala Sub County 19,039 and Teso South Sub County 36,569 of Busia County in Kenya. Key informants were the director of the Department of Fisheries in Busia County and two extension officers each from the surveyed sub-counties of Teso South and Bunyala in Busia County. A purposive sampling technique was used to select the study site. Households in the study areas of two sub-counties were sampled using a multi-stage proportional random sampling approach. Taro Yamane's (1967) formula was used to calculate the household sample size for the study (55,608) proportionately distributed in the two sub-counties, Bunyala (0.342) and Teso South (0.658), ending up with a sample size of 384 household heads.

Data was collected using quantitative and qualitative approaches and methods. The study used structured questionnaires (household questionnaires), focus group discussion guides (households), interview guides (key informant interviews with the Ministry of Agriculture, Livestock, and Fisheries, Sub County Directors of Fisheries, and Sub County Extension Officers), and photography. The validity of the study was assured by cross-checking the research questions with supervisors. Reliability was tested by conducting content validity to test the consistency of the questions, which had an alpha score of 0.86, which was larger than 0.70 and thus passed the test. The data was analyzed descriptively and analytically. This was achieved with the aid of the Statistical Package for the Social Sciences, version 25. The resulting frequencies and percentages were presented using tables and figures. Qualitative data was first classified based on common attributes or themes and reported verbatim.

III. RESULTS

4.1 Fish Fingerlings

This section covered the type of fish fingerlings hatchery, the price of fingerlings and the preferred type of fingerlings.

4.1.1 Type of fish fingerling hatchery

The study investigated whether the fish farmers acquired fish fingerling from either government hatcheries or private hatcheries. The findings are presented in Figure 2.

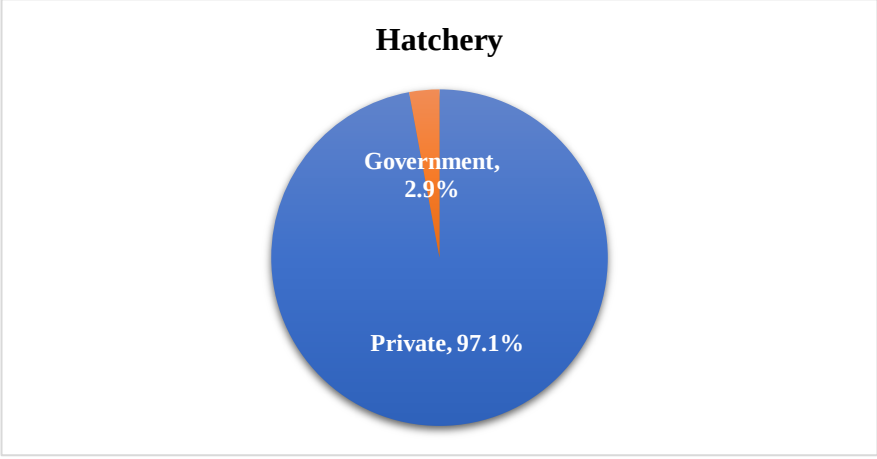

Figure 2

Type of Fingerling Hatchery

From Figure 2, 97.1% of the household acquired their fish fingerlings from private hatcheries and only 2.9% acquired their fingerlings from a government hatchery. The catchment areas for fish fingerlings extended as far as Vihiga County and Uganda. Busia County as at the time of this assessment had only one government fish fingerling hatchery (Wakhungu Hatchery) - located in Bumala area, Samia sub-county of Busia County. Therefore, the Wakhungu hatchery with only 2.9% of the fish farmers 'accessing fish fingerlings was unable to sustain the burgeoning number of fish households practising fish farmers in Busia County. Moreover, one of the key informants said that:

> "… *Wakhungu Fish farm has not been well maintained and hence was producing poor quality fish fingerlings. This discouraged many farmers from acquiring fish fingerlings from Wakhungu Fish Farm. Therefore, fish farmers have had to go far even into Uganda to secure fingerlings*."

Previously, Busia County benefited a lot from donor programmes. Therefore, without commitment to investing in quality fish fingerlings production, this gap in fingerlings production will be inevitable. Koge et al. (2018) stipulate that projects started in a community intending to mitigate the economic and social inadequacies such as aquaculture dwindle as soon as the project decommissions. This is quite a challenge to the sustainability of a project beyond donor funds. This was suggested by one of the members in a focus group discussion who said that:

> "… *Farmers have been over-relying on help and funding from the donor organisation. Such behaviour made farmers, not own projects and realise the value in fish farming regarding fish fingerling production at home*."

Another member in the FGD forum added by saying that:

> "… *Fingerling production for a long time was centralised, which made it difficult to access especially farmers from Teso South. This demoralised farmers to invest in fish farming and take the programs lightly*."

A previous study suggested that fingerling production is an African problem where many governments have failed to invest in hatcheries that would otherwise address the shortages of quality fingerlings (Cai et al., 2017). Therefore, the private sector took advantage of the government's non-committal in investing in quality fish fingerlings production and they have dominated the sector. From the foregoing, the key informant stated that:

> "… *In Bunyala sub-county, there are two privately run fish hatcheries – Rudacho and Hydo – that produce fish fingerlings for both cage aquaculture and pond aquaculture. However, the quality of fingerlings is still an issue and the supply is still not enough to serve farmers in Bunyala sub-county where most of the fish farmers cross Lake Victoria to Uganda for fingerlings*."

The plate below shows the fish hatcher farm shores of Lake Victoria in Port Bunyala (Port Victoria) in Bunyala Sub County in Busia County.

Plate 1

A Private Fingerling Production Farm in Bunyala Sub County in Busia County

4.1.2 Price of fingerlings

The study investigated the prices of fingerlings in order to establish whether the cost was favourable for the households in Bunyala and Teso South sub-counties. The results are presented in Figure 3.

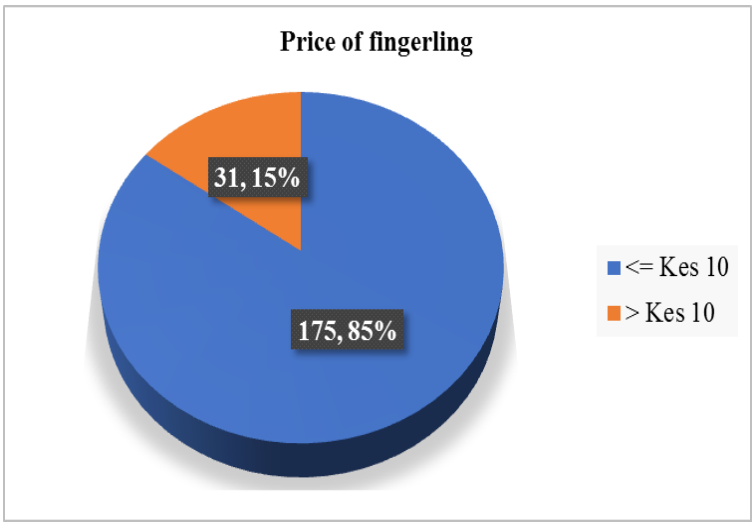

Figure 3
Price of a Fingerling

From the findings in Figure 3, it is clear that 85% of the households practising fish aquaculture bought a fingerling at Kenya shilling of 10 or less. However, only 15% of them bought a fingerling for more than Kenya shillings 10. The study observed that fish farmers were travelling long distances to acquire fish fingerlings. The transportation charges increase the cost of production and are of serious concern to households to scale up aquaculture. The study revealed that the private sectors, which dominated fingerling production for fish farmers in Teso South and Bunyala sub-counties were not regulated and could overprice fingerlings. This was supported by the key informant who said that:

> "*… Farmers go outside Busia County to purchase fingerlings. Mostly, farmers from Teso South go to Vihiga County to acquire fish fingerlings. Moreover, here in the Teso South sub-county, there is no single fish fingerlings production centre. We need at least one here at Simbachai*."

Consequently, another key informant stated that:

> "*… Farmers from Bunyala sub-county acquire their fish fingerling from Wakhungu fish farm. We have other new fish hatcheries established such as Rudacho Fingerling Production farm and Hydro Hatchery in Bunyala sub-county, which we hope will address the deficit in Busia County*."

The main challenge that Busia County smallholder fish farmers experience is the high cost of quality fish fingerlings. In Teso South, at the time of data collection, there was no fish farm; however, Kamarinyang Aqua Park was under development. Therefore, all the farmers practising semi-intensive fish farming acquire fingerlings from fish hatcheries in Vihiga County. This has made it expensive for small-scale fish farmers. Besides, the opinion of the key informant said that:

> "*… Farmers from Teso South are really emphasizing the need to have a fish hatchery near them because they cover long distances to purchase fingerlings, where transportation fee increases their challenges*."

This study concurs with the previous study by Rurangwa et al. (2015), that the major constraint to the development of aquaculture is the lack of infrastructure for fingerlings. It is of great concern for most of the households practising fish farming to acquire fish fingerlings, despite having Wakhungu Hatchery - a government facility for fingerlings production in Busia County. Moreover, the hatchery is not conveniently located for most fish farmers in the Teso South sub-county and Bunyala sub-county. The findings suggested that at least every sub-county in Busia County should have a fish hatchery for fingerlings production in order to promote fish farming and improve households' socioeconomic performance.

4.1.3 Preferred Type of Fingerlings

The researcher investigated whether the farmers in Bunyala and Teso South sub-counties preferred monoculture or mixed-cultures. The findings are shown in Figure 4.

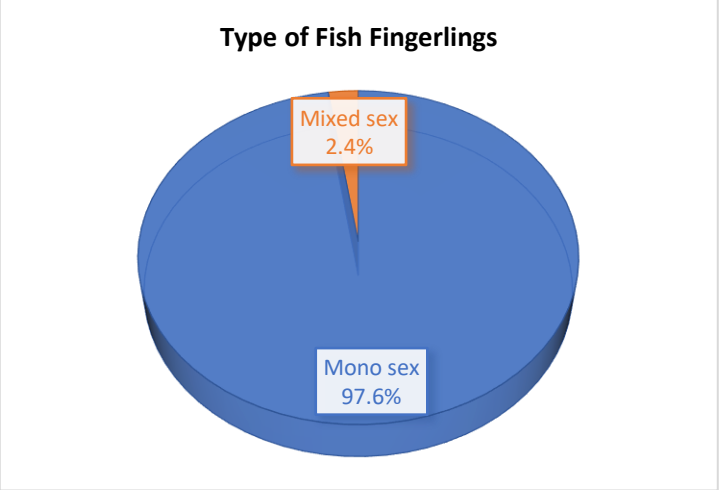

Figure 4
Preferred Fingerling Sex Cultured

Findings in Figure 4 show that 97.6% of the households interviewed preferred mono-sex fingerlings over mixed-sex. This was one of the ways farmers mitigated competition and overcrowding and maximised quality production. Key informant corroborated this finding by stating that:

> "… *Mixed-sex does not work better in small spaces where ponds have limited dissolved oxygen. We have been educating small-scale farmers to embrace mono sex which has better returns*."

This finding was in line with a previous study (Fry et al., 2014), that mono-sex fingerlings grew faster with minimal competition in the pond. Besides, fast growth, the mono-sex fingerlings grew bigger thus promoting quality production and high yield. Mono-sex aquaculture is important for smallholder households because it promotes production by eliminating the competition for pond resources and mating deprivation. This finding was echoed by a key informant, who stated that:

> "… *Culturing males and females in the same pond promotes competition for resources and mating rites. As such, fish production is affected, which hurts the profits of the farmers."*

While emphasizing their observations, another key informant added and said that:

> "… *You have seen the ponds, they are small therefore to maximise the available space and yields, mono sex is preferred. We always remind the farmers to invest in mono sex that will assure them maximum benefits*."

This study revealed that to maximise the profits and investments made in aquaculture, especially pond culture, mono sex is the best way to go for most smallholders. Mixed-sex culture is preferred for cage aquaculture in Lake Victoria. Cage aquaculture assures enough circulation of oxygen and space for fish to reside addressing space challenges experienced in smallholder ponds.

Moreover, to achieve poverty reduction and nutrition promotion for smallholder farmers, this study observed that the goodwill from both county and national governments and the support from the family members in fish farming promotes more investments and human resources in fish farming. It is known that Kenya has a vast network of inland freshwater; this could be tapped to mitigate poverty in most rural parts of Kenya. The findings acknowledge that both the national and county governments' goodwill and social acceptance are important in promoting aquaculture. This is also a notion that is shared by Krause et al., (2015).

A correlation to determine the strength and direction of the relationships between hatcheries selling fingerlings, the price of fingerlings and the sex of fingerlings preferred (Table 1).

Table 1

Correlation of Fingerling Hatchery, Price Of Fingerling and Preferred Sex For Breeding

		Fingerling hatchery	The price of a fingerling	Fingerling sex preferred
Fingerling hatchery	Correlation Coefficient	1.000		
	Sig. (2-tailed)	.		
	N	384		
The price of a fingerling	Correlation Coefficient	.073	1.000	
	Sig. (2-tailed)	.298	.	
	N	384	384	
Fingerling sex preferred	Correlation Coefficient	.027	-.066	1.000
	Sig. (2-tailed)	.697	.343	.
	N	384	384	384

Correlation tests were that fingerling hatchery and price of a fingering, $r = 0.072$, $p = 0.298$; fingerling hatcher and preferred sex of fingerlings (mono sex or mixed sex), $r = 0.027$, $p = 0.697$ and price of a fingerling and preferred sex preferred, $r = -0.066$, $p = 0.343$. The correlation result showed that the variables tested were insignificantly not related to each other. This meant that apart from fingerlings hatchery, the price of a fingerling and the sex of the fingerlings, other attributes hampered the performance of freshwater aquaculture such as education to farmers on feed processing, marketing and access to loans to boost aquaculture and storage of fish to mitigate losses as well as value addition prior to selling.

4.2 Fish feed

The study investigated where fish feed was purchased and the prices for the feed per kilogram. According to the household survey, it was established that all the fish farmers interviewed purchased fish feeds from Agrovet shops near them. The Economic Stimulus Project of 2009, the Western Kenya Community Driven Development Programme (WKCDD) and the Programme for Agriculture and Livelihoods in Western Communities (PALWECO) invested heavily in aquaculture. This gave the Agro vet shops a ready market for fish feed in Busia County. The findings showed that fish feeds were readily available. The key informant contributed to the question on fish feed and said that:

> "… *Agro vet shops are available at least in every sub-county in Busia County. These agro vet shops stalk fish feeds because of the increased number of households practising fish farming in Busia County*."

While another key informant added by stating that:

> "… *We also purchase fish feeds in bulk and give them to farmers who pay in instalments to enable them to acquire the feeds conveniently and at a fair price*."

4.2.1 Price of Fish Feed

The findings showed that all the households had access to fish feeds from the local Agrovet shops. The fish feeds were a challenge price-wise to small-scale farmers in Bunyala and Teso South sub-counties. The cost of fish feeds per kilogram was unsustainable. It was expensive for most rural farmers as they were expected to feed about one thousand fingerlings with four kilograms of feeds per day depending on the age and size (Plate 2). Therefore, most farmers were unable to sustain the momentum. It was established from the key informant stating that:

"*… I have received reports from the extension officers at sub-counties saying that farmers are overwhelmed by the high cost of fish feeds. In fact, they wish to have a fish feed industry locally in order to address the high cost of feeds*."

Plate 2
Fish Feeding in Teso South Sub County

The study sought to evaluate the price of fish feed as summarised in Figure 5.

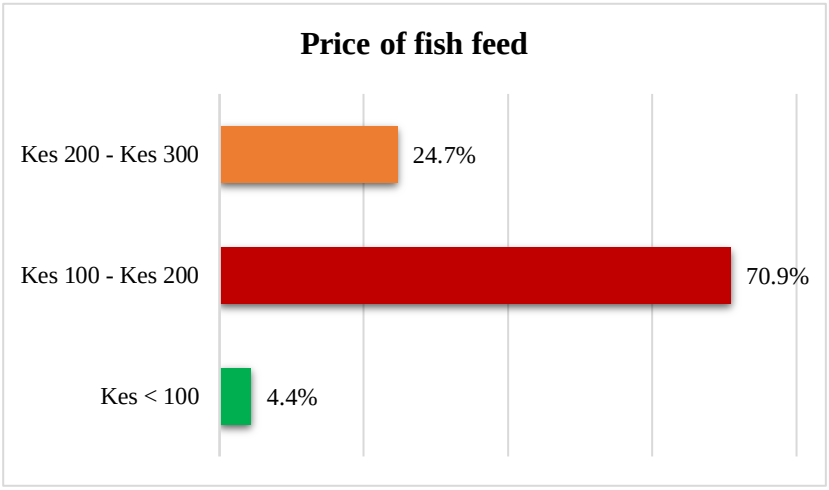

Figure 5
Price per Kilogram Of Fish Feed

The finding in Figure 5 shows that 70.9% of the fish farmers interviewed were purchasing fish feed between Kshs 100 and Kshs 200 per kilogram. This also indicates as per the data that 70.9% of the fish farmers purchased a twenty-five kilogram of fish feed at Kshs. 3,300. This is the standard price range of the feeds depending on the diameter of the feeds.

However, it was established that 4.4% of the fish farmers interviewed, purchased a kilogram of fish feed at less than Kes 100. This price was common in Bunyala sub-county where a few farmers procured their fish feed from the sub-county fisheries offices, which had incentives. This finding was corroborated by the key informant, who stated that:

> "… *The average cost of the feeds in Busia County by most of the agro vet shops is Kshs 120 per kilogram of feed. Our department procures these feeds and sells them to farmers at Kes 88, mostly in Bunyala sub-county*."

The findings in this study show that the County Government of Busia through its directorate of fisheries has been trying to subsidise the fish feeds in Bunyala sub-county – a sub-county endemic to floods. The household interviews showed that farmers were complaining about the high prices of fish feeds. The key informant interview triangulated these findings where it was stated that:

> "…*Households are struggling to purchase the feeds which are quite expensive for most of them. Remember, they are the rural poor trying out aquaculture for change. Securing feed is challenging to some until they even feed them food remains as an alternative*."

V. CONCLUSIONS & RECOMMENDATIONS

5.1 Conclusions

The study concludes that the private sector hatcheries were the main distributors of fingerlings to farmers. The County Government of Busia was not determining the prices of fish fingerlings hence could have resulted in the higher price of a fingerling. The transportation cost of the fingerlings was high hence contributing to the high cost of production to small-scale households in Busia County. Farmers preferred monoculture over mixed culture in order to avert competition overfeed due to the increased population. Agrovets are the main providers of fish feeds to farmers; however, the feeds were expensive to households of small-scale farmers.

5.2 Recommendations

Fingerling hatcheries have received relatively little attention, which is reflective of their investment in Busia County. Therefore, the Government of Kenya and the County Governments of Busia should rethink and invest in installing government hatcheries in all sub-counties to promote freshwater aquaculture. Furthermore, households will have access to affordable fingerlings and that would promote the sustainability of freshwater aquaculture.

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