Demographic and Socioeconomic Characteristics of Fish Farmers and their Effects on Fish Farming Management Practices in Kakamega County, Kenya

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Abstract- Fish farming in Kakamega County, Kenya faces the challenges of underinvestment and poor management, which often results in low yields. Many farmers have shied away from investing in fish farming and some who have tried fish farming have later on abandoned their fishponds. This study determined the relationship between the demographic and socio-economic characteristics of fish farmers and fish farming management practices in Kakamega County, Kenya. The study focused in Lugari, Lurambi and Khwisero sub-counties in Kakamega County, Kenya. The main study population was fish farmers in fish farming households. The correlational research design was used. The study employed multi-stage random sampling of fish farms. The results were that male members of the society dominate fish farming in Kakamega County. A Chi-square test ($\chi 21, 0.05 = 9.19$, $p = 0.031$) of independence showed that the ownership of the fishponds by women and land tenure are significantly ($p < 0.05$) related implying that ownership of the fishponds by women depends on whether the women also own the land. Many of these households represented by 20.31 % ($n = 77$) have 7 members and with this large number of people, they are likely to use family labour at their fish farms and this reduces production cost. The study concluded that demographic and socio-economic characteristics of fish farmers in Kakamega County affect the application of fish farming management practices since they involve the interactions of people and psychological and situational factors and therefore determine investment patterns in the fisheries sub-sector. They also influence fish farmers' response to changes in technology and affect participation in fish farming development. The study recommended the need to strengthen the capacity of fish farmers irrespective of their demographic and socioeconomic status and the need to promote an overall enabling environment in order to increase their response to technological changes and participation in the development in fish farming.

Index Terms- Demographic characteristics, Fish farming, Fish farming management practices, Socio-economic characteristics

1.0 INTRODUCTION

Fish production has been the fastest-growing food industry in the world for the last 40 years and it is expected to remain so in the near future (Béné *et al.*, 2015). In Africa, small-scale fish farming has continued to grow steadily with millions of poor families relying heavily on fish farming as a livelihood (Gatonye, 2017). Fish farming has great potential of growth in Kakamega County due to the presence of a wide variety of water sources such as rivers, springs, dams and rainfall (County Government of Kakamega, 2015). Fish farming households in western Kenya where Kakamega County is located mainly culture *Oreochromis niloticus* (Nile tilapia) and *Clarias gariepinus* (African catfish) (Nguka *et al.*, 2017). Land fragmentation coupled with the rugged terrain in the county permit farmers to construct only small fishponds which although cumulatively add up to a large pond area, production in the area is still far below the market demand (Kiiru and Munguti, 2014). According to Shitote *et al.* (2013a), the major problems facing fish farmers in Western Kenya are high costs of feed, shortage of quality fingerlings and feeds, flooding, poor security and poor fish farming practices. Other challenges that affect fish farming in Kakamega County are poor road infrastructure, poor pond management practices, limited access to adequate sources of water, high costs of fish feed, poor location and high cost of construction of fishponds (Kundu *et al.*, 2016).

Understanding the factors influencing the development of aquaculture is critical in planning (Kundu *et al.*, 2016). Warner and Sullivan (2017) similarly state that an understanding of social, cultural and economic attributes is important to development partners and communities as a basis for sustainable investments in livelihood and to policymakers in matters relating to the governance of these livelihoods. Social attributes influence how people participate in fish farming. The socio-economic characteristics pertaining to demography, means of production and investment, income and expenditure pattern of people living in a particular location strongly influence their responses to technological changes and participation in development schemes (Pandey and Upadhayay, 2012).

Ondiba and Matsui (2019) opine that social attributes such as age, education, family size, annual income, contact with extension services, cosmopoliteness, innovativeness and aspiration in farming influence entrepreneurial behaviours among people and the adoption of integrated homestead farming technologies. The age of rural women has a significant negative correlation with their adoption of integrated homestead farming technologies while their other socio-economic characteristics, namely, education, family size, annual income from field crop, annual income from homestead, contact with extension media, cosmopoliteness, innovativeness and aspiration in farming have significant positive relationships with their adoption of integrated homestead farming technologies (Aurangozeb, 2019).

Fish farming is an activity that requires a lot of inputs and workforce especially in the initial stages of digging the pond than in the routine management of the pond after stocking including the application of manure in the pond, feeding the fish and cleaning the pond (Akankali *et al*., 2011). Therefore, human capacity is of utmost consideration in the development of fish farming since whereas the aquaculture system exerts control over fish production through its design and water quality and quantity, the farmer has control over the reproduction of fish through genetic selection and breeding, feeding and disease control (Lahsen and Iddya, 2014). The availability of resources and the farmer's management ability determine the most suitable level of intensity in farming (FAO, 2018). In Kakamega County, the majority of the fish farmers (75.6 %) have fishponds that are less than 300 M^2 (Shitote *et al*., 2013b). There is a need to focus on the choice of technologies and their adoption in order to increase production, productivity and farm incomes (Bundi *et al.*, 2018). The likelihood of adopting a new technology e.g. use of improved feed in Kenya will surge with improved extension service delivery, access to government-subsidized feed, and ease of market access for purchasing improved feed and sale of mature fish (Amankwah *et al*., 2018).

1.1 Statement of the Problem

Fish farming in Kakamega County faces the challenges of underinvestment and poor management, which often results in low yields. Production in the county is low and despite efforts by several players to revitalize fish farming, the development process is at a snag and is characterized by pond productivity that is low and not rising (Nguka *et al*., 2017). Many farmers shy away from investing in fish farming and some who try fish farming abandon their fishponds later on. These factors have considerably contributed negatively to the development of the fisheries sub-sector in the county. The yield of fish in Kakamega County is below expectation since it does not meet the demand (Otieno, 2014). Even though the fish farming management practices that are promoted by various players appear quite simple, less complicated and more appropriate for local adoption, there is a slow rate of adoption (Kiiru and Munguti, 2014). The study seeks to determine whether there is a relationship between the demographic and socio-economic characteristics of fish farmers and fish farming management practices in Kakamega County, Kenya.

2.0 MATERIALS AND METHODS

The study was carried out in Kakamega County in Kenya with a focus in Lugari, Lurambi and Khwisero sub-counties. The main study population was fish farmers in fish farming households. The correlational research design was used. The study had the objectives of determining the relationship between the demographic and socio-economic characteristics of fish farmers and fish farming management practices in Kakamega County, Kenya.

Kakamega County has 12 sub-counties. Three sub-counties were purposively sampled to represent their ecological zones and the farming systems; Lugari and Lurambi from the Upper Medium (UM) ecological zone and Khwisero from the Lower Medium (LM) ecological zone. Lugari Sub-county also formed an important area of study because it had the highest number of fishponds in the county. Lurambi Sub-county has the Kakamega Fish Mini-processing Plant and, therefore, ready market for fish. Khwisero Sub-county had an active fish farmers' cooperative. In addition, it was important to concentrate on these sub-counties in order to allow in-depth exploration and understanding of the fish farms and thus increase the quality of data collected. The study employed a multi-stage random sampling of fish farms. 384 fish farmers were sampled from the three sub-counties. However, the sample size was added another 10 % to be 400 fish farmers in order to take care of non-response or lose of data during the data collection process. The fish farmers were proportionately sampled in the selected sub-counties in ratios relative to the total number of fish farmers in the sub-county.

Questionnaires containing closed and open-ended questions were administered to the fish farmers and/ or fish farm managers at the household level. During the visits at the fish farms, observable existing fish farming management practices including the site of the fishpond, water quality, methods of controlling predators, methods of controlling diseases and method of controlling pests among others were recorded and photographed as a way of supplementing the information collected on the questionnaires.

Three focus group discussions (FGDs) were organized for the fish farmers at major townships in the selected sub-counties; Kakamega Town, Lumakanda Township and Khwisero Township. Interviews were held with purposively selected key informants including the chairpersons for Kakamega County Fish Farmers Cooperative and Khwisero Fish Farmers Cooperative, one official from the Aquaculture Association of Kenya (AAK) and the Fisheries Director, Kakamega County. Secondary data were obtained from farm records, documented reports in various offices that were visited and policy documents regarding fish farming in Kakamega County and Kenya.

The demographic and socio-economic characteristics of the fish farmers were summarized in tables, means and graphs using Microsoft Excel and Statistical Packages for Social Scientists (SPSS) version 20. These demographic and socio-economic characteristics were gender, household/ family size; land size and tenure; pond ownership; experience and age; education level; social participation and membership to farmers' groups, cooperatives and Aquaculture Association of Kenya (AAK); household income distribution and expenditure pattern; occupation of the fish farmer; and consumption of fish. They were analyzed using descriptive and inferential statistics and qualitatively using narrative analysis and correlated with fish yield in order to determine if there were any relationships. Inferential statistics included correlation and Chi-square tests of independence, variation and association.

3.0 RESULTS AND DISCUSSIONS

The study sought to determine the relationship between the demographic and socio-economic characteristics of fish farmers and their application of fish farming management practices in Kakamega County, Kenya. These socio-economic characteristics include gender, household/ family size, education level, occupation, consumption of fish, age, experience, social participation, size of land, nature of land tenure, nature of pond ownership and household income distribution pattern.

3.1 Gender

Male members of society dominate fish farming in Kakamega County. Of the fish farmers, 93.4 % (n = 358) were male farmers. This research unveiled two scenarios of women involvement in fish farming. First, women who have their own fishponds and take part throughout the fish farming value chain. This is not common and accounts for about 4.43 % (n = 17) of the fish farmers as revealed by the study and of interest to the researcher. Secondly, women who participate jointly with their husbands in the management of fish farming by contributing to one or more of the activities under the fish farming value chain. This is the most common scenario and exists in almost all fish farming households.

Women in most fish farming households in Kakamega County participate in almost every aspect of the fish farming right from the general management of the fishponds, post-harvest handling and marketing. However, the research went further to investigate why very few women own fishponds in Kakamega County by looking at whether these women also owned the land from where they were doing fish farming. Table 1 presents this.

Table 1: Comparison by land tenure between women who own fishponds and women who do not own fishponds but participate in managing family fishponds in Kakamega County, Kenya

Tenure by women of the land where fish farming takes place	Percentage of women in the category
	Women who own fishponds (N = 17)
Women who own land	76.47 % (n = 13)
Women who do not own land	23.53 % (n = 4)

Source: Researcher (2018)

It was clear that most of the women who own fishponds also own the land from where they are doing fish farming. This represented 76.47 % (n = 13) of the women who have their own fishponds and take part throughout the fish farming value chain. Some other 23.53 % (n = 4) of the women who have their own fishponds and take part throughout the fish farming value chain has acquired land through leasing and using the land for fish farming. The women who do not own fish ponds but participate jointly with their husbands in managing family fishponds do not themselves own the land from where they are doing fish farming. These women are either joint contributors in the investment in fish farming or co-managers or both. A Chi-square test ($\chi^2_{1,\ 0.05}$ = 9.19, p = 0.031) of independence showed that the ownership of the fishponds by women and land tenure are significantly ($p < 0.05$) related implying that ownership of the fishponds by women depends on whether the women also own the land.

Key Informant Interview (KII) findings from the Department of Fisheries in Kakamega County showed that Kakamega County has about 8,336 fishponds that are owned by about 7,845 fish farmers of which less than 5 % (n = 7,845) of them are women. The field findings are very close to the Key Informant Interview (KII) findings from the Department of Fisheries in Kakamega County where about less than 5 % (n = 416) of the fishponds in the county fall under the first scenario and here women own fishponds and do most of the work in managing the ponds.

Information from all the focus group discussions (FGDs) revealed that the constraints to ownership of fishponds by women are limitations in accessing productive land resources, socio-cultural boundaries, and limitations in decision-making at the household level. During the focus group discussion (FGD) in Lurambi, one of the male farmers (Participant 1 from Lurambi, July 3, 2017) stated that:

> "Traditionally among us Luhyas, women were restricted within homesteads by socio-cultural and religious boundaries. The women are usually responsible for activities within the household such as childcare, food preparation and washing; and agricultural activities that do not require them to move outside the homestead such as vegetable gardening, post-harvest handling of produce and care of poultry and livestock. The women were in some instances allowed to take the produce to the market. Today, with the changing social context, women are increasingly becoming involved in income-generating activities such as farming."

It was observed that most of the fishponds were located near homesteads. This makes the women participate actively in the works at the fishponds while simultaneously attending to their roles at the homestead.

Shitote *et al*. (2013b) also observed the dominance of men in fish farming in Kakamega County. Luomba (2013) reports that capture and aquaculture have often been regarded as male responsibilities. However, this study found out that women also participate in fish farming. Where fishponds are located within and close to homesteads, women are able to work simultaneously on the fishponds and at their homes without forcing them to be away from their homes for long periods that might force them to neglect some of their roles at their homes (Pandey and Upadhayay, 2012).

According to Huyer (2016), closing the gender gap in fish farming and building the capacity of women for participation in fish farming is likely to boost the productivity of fish farming and generate gains in terms of lifting many households out of poverty and ensuring household food security, economic growth and social welfare.

Luomba (2013) says that the important role played by women in aquaculture have to some extent been derailed by land tenure systems which give ownership rights to males, inaccessibility to credit and savings services and facilities, low literacy and inadequate technical knowledge on pond management. Kiragu and Flohr (2016) say that with most of the household land in Western Kenya held by men, leasing remains a viable option for women to wish to participate in agricultural production although there is a need for a properly guided way for leasing in order to protect the rights of both the landowner and the leasee. Hence, women in Kakamega County can lease land and use it for fish farming.

3.2 Household/ Family Size

Majority of the fish farming households in Kakamega County represented by 20.31 % (n = 77) have 7 members. Table 2 presents the distribution of household sizes.

Table 2: Distribution of household/ family sizes of fish farming households in Kakamega County, Kenya

Household/ family size	Percentage (&) distribution	Percentage (%) relying mainly on family labour
1	1.0	9.4
2	7.7	4.5
3	12.2	7.8
4	16.8	4.5
5	8.7	3.7
6	11.2	3.6
7	20.4	5.3
8	13.3	7.5
9	4.1	7.3
10	1.5	11.3
11	2.6	18.3
12	0.5	16.8
Total	**100**	**100**

Source: Researcher (2018)

Even though most of the fish farmers represented by 46.50 % (n = 178) are the main sources of labour at their fish farms, many of those who receive labour assistance represented by 34.50 % (n = 132) depend on their family members as a source of labour for the management of their fishponds. Only 18.90 % (n = 72) of the farmers have employed managers and other workers at their fish farms. 19.10 % (n = 73) of the fish farmers have had their family members assist them in digging their fishponds. Of the labour force provided by the family members, the spouses account for 53.00 % (n = 203), the children account for 36.20 % (n = 139) and the other family members account for 10.90 % (n = 41).

A Chi-square test ($\chi^2_{11,\ 0.05}$ = 14.7, p = 0.041) of variation showed that there was significant (p < 0.05) variation in the household family size implying that the individuals listed as members of the household have no effect on the total household size. A Chi-square test ($\chi^2_{11,\ 0.05}$ = 47.56, p = 0.023) of association showed there was a significant (p < 0.05) relationship between household size and dependence on family labour implying that fish farmers whose households or families have a large number of people are the ones who are likely to consider family labour as their main source of labour.

However, as can be seen from Table 2, some of the households that have large numbers of members do not necessarily rely on family labour. This is because the involvement of any family member in the labour at the fishpond depends on the availability of that member since there are seasonal variations in the fishpond activities, the social relationship of the member and the fish farmer, the health and the age of the member, which determines the ability of that member to undertake the work.

Those farmers who themselves made their own fishponds account for 24.00 % (n = 92) of the farmers interviewed. The study revealed that majority of the households that used household labour to dig their fishponds had household sizes with at least 8 people. Government programmes such as Economic Stimulus Programme (ESP), Kenya Agricultural Productivity Programme (KAPP) and Kenya Agricultural Productivity and Agribusiness Programme (KAPAP) promoted fish farming in the area and, therefore, made fishponds for 37.30 % (n = 143) of the fish farmers interviewed.

Use of household labour reduces production cost and this means that the fish farmer can use the money that he would have used in employing labour in other operations at the fishpond thus increasing production. The results in Table 2 corroborates the findings of Omoregbee *et al.* (2013) and FAO (2015) that rural dwellers, similar to the research area, have large families. Shitote *et al.*, (2013b) reports that there is a high variation in household sizes of fish farmers in Western Kenya and that the large family sizes are due to polygamy and poor adoption of family planning methods. Although a large family size may provide the needed labour at the farm, the impact of the large family size on labour may also be insignificant because of the limited labour needed at the fishpond.

A large family size may also mean reduced economic welfare of the household, especially where dependency from the fish farmer is high (Omoregbee *et al.*, 2013). Dang *et al*., (2002) found out that the availability of family labour and social connections of households were some of the major determinants of successful adoption of a rice-fish system.

3.3 Land Size and Tenure

The average land size of the fish farmers as revealed by the study was 1.2 acres. The smallest total land acreage was 0.132 acre and the largest acreage was 24.5 acres. A Chi-square test ($\chi^2_{3,\ 0.05}$ = 19.56, p = 0.012) of variation showed there was a significant (p < 0.05) variation in the land sizes. Similarly, a Chi-square test ($\chi^2_{4,\ 0.05}$ = 29.96, p = 0.041) of association showed there was a highly significant relationship between land size and total area under fishpond. This implies that fish farmers with large pieces of land are most likely to establish big fishpond or many small fishponds that cumulatively add up to a large fishpond area. This improves on the economies of scale of operations/ practices in the fish farming enterprise.

Majority of the fish farmers represented by 96.10 % (n = 369) have exclusive ownership of the land from where they do fish farming compared to only 3.90 % (n = 14) who have leased land from where they do fish farming. However, only 23.21 % (n = 85) of the fish farmers who have exclusive ownership of the land from where they do fish farming have title deeds.

A Chi-square test ($\chi^2_{1,\ 0.05}$ = 3.28, p = 0.411) of association showed there was non-significant (p > 0.05) relationship between land tenure and access to credit implying that fish farmers with title deeds are less likely to use them as collateral when accessing loans. Such loans can provide useful capital for fishpond establishment or simply for increasing production at the fishpond.

It was observed that although some of the pieces of land were big, some sections of the land were very steep and therefore would not economically support fishpond establishment, especially in Khwisero Sub-county. Khwisero Sub-county where there is small-scale intensive farming had most of the smaller pieces of land while in Lugari Sub-county where there is small, medium to large-scale intensive farming had most of the larger pieces of land.

The focus group discussion (FGD) at Khwisero reported that most of the farmers in the area do not have title deeds for their pieces of land. The fish farmers also said that population increase in the area has led to land fragmentation and that the expensive succession and land subdivision processes are the main reasons why the farmers are not able to acquire title deeds. The focus group discussion (FGD) at Lumakanda also reported that some financial institutions are reluctant to accept title deeds from fish farmers as collateral for loans until the fish farmers provide additional security. These farmers said that sometimes these financial institutions demand that the farmers wishing to take loans must have saved with them some amount of money before they can qualify for loans.

The Kakamega County Integrated Development Plan (CIDP) 2018-2022 reports an average farm size of 1.5 acres for small-scale holders and 10 acres for large-scale holders. The CIDP further explains that Lugari and Likuyani sub-counties mostly have large parcels of land and that land size reduces gradually towards the Lower Region of the county where Khwisero Sub-county is located due to land fragmentation. Lack of secure land tenure plays a big role in constraining participation and ultimately adoption of sustainable land management technologies (Kiragu and Flohr, 2016).

There are benefits associated with a fish farmer having freehold ownership of land from where he/ she is doing fish farming. First, the farmer will not incur rent expenses that farmers who lease would incur and, therefore, the farmer ploughs much of the capital investment in production rather than rent. Second, the farmer has a strong emotional attachment to the land from where they are doing fish farming and this means that the farmer will comfortably invest in its protection and development through sound management practices which ensure environmental sustainability which is an important factor in environmental conservation and hence sustainable development. Third, where the farmer has documents to prove ownership of the land, he/ she can use such documents as collaterals in financial institutions when he/ she goes for a loan. This means that land will provide the farmer with an assurance of recovery in the event of shocks in fish farming and thus encourages production.

Provided there is adequate financial capital and labour for investment in fish farming, farmers with large pieces of land have the capacity to establish large or more fishponds whereas farmers with small pieces of land have a small area under fishponds unless they lease extra land a situation that adds to the expenditure in fish farming (Osondu and Ijioma, 2014). Exclusive ownership of property such as land means secured property rights that give sufficient incentives to the farmer to increase efficiency in terms of productivity (Dang *et al*., 2002). Jérôme and Lionel (2009) report that land provides security for loans and is an assurance in the event of shocks in farming. Dekker (2017) describes the land as social security and says that land is an incentive for agricultural production. This means that farmers who own land will feel encouraged to establish fishponds more than those farmers who do not own land.

3.4 Experience and Age

The study disclosed that fish farming has been practised by the majority of the fish farming households in Kakamega County representing 79.24 % (n = 304) for more than five years. Other farmers representing 20.76 % (n = 79) have practised fish farming for only five years or less.

Fish farming has attracted middle-aged farmers most of who are between 40 and 60 years. These represent 72.16 % (n = 277) of the household heads interviewed. Other households representing 11.23 % (n = 43) have their household heads between 30 and 40 years age and another 12.56 % (n = 48) have their household heads below 30 years age. Those fish farmer or fish farming household heads who are above 60 years of age represent 4.17 % (n = 16).

There was a significant ($p < 0.01$) positive correlation between the experience of fish farmers and the average yield of fish per hectare ($r = 0.532 \pm 0.25$). There was also a highly positive correlation between the experience of fish farm managers and the average yield of fish per hectare ($r = 0.651 \pm 0.23$). This implies that the average yield per hectare depends on the experience of the fish farmers and the fish farm managers. In an interview with a 75-year old fish farmer (Participant 2 from Khwisero, July 6, 2017), he stated that:

> "As I grow in age my fishpond also tend to age with me. Without remedial actions to clean it by removing silt, my production has decreased. Over the years, I have been experiencing a decrease in labour since my children and grandchildren who provided labour have gone to schools outside the home area and others have gotten involved in their own businesses including their own families."

The experience here connotes a product of a long-term personal encounter with fish farming and does not always depend on age. Osondu and Ijioma (2014) report that there is usually a decline in interest in fish farming as the farmer grows in age and family expenditure increases to a point where the farmer finds fish farming uneconomically rewarding. These field findings are similar to the findings by Oluwasola (2011) who observed that there is no relationship between the production of fish and the age and experience of the fish farmer. Experience affects the production of fish farming because farming with experience depends less on external technical assistance than farming without experience (Huang, 2018). This means that a fish farmer without experience ploughs much of the resources and time in accessing external technical assistance and this affects fish production.

3.5 Pond Ownership

Private entrepreneurs dominate ownership of the fishponds in Kakamega County. However, some institutions own some of the fishponds and fingerlings/ seed stock supply facilities. According to the field data, individually owned fishponds represent 89.70 % (n = 344) of the fish farms of the fish farmers compared to 9.30 % (n = 35) that are jointly owned by groups of either two or more farmers and institutions.

A Chi-square test ($\chi^2_{1,\ 0.05} = 11.32$, $p = 0.034$) of association showed that there was a significant ($p < 0.05$) relationship between pond ownership and the fraction of the household income that is used in upgrading fish farming. This implies that fish farmers who have own fishponds as individuals have stronger emotional attachments to their fishponds than those

who are in groups. This motivates the farmers to invest more of their individual resources and time in fish production.

A Key Informant Interview (KII) with the County Director of Fisheries, Kakamega County revealed that Lutonyi Fish Farm in Kakamega Town that is owned by the County Government of Kakamega (CGK) is used as a learning and demonstration site for fish farmers and students. He also pointed out the advantage of group ownership is that it makes it easy for farmers to mobilize resources and labour.

Kiragu and Flohr (2016) reported that groups have their own challenges such as mismanagement of resources and this discourages farmers to join groups. Fish farmers are more likely to invest more of their individual resources and time in fish production at their own fishponds than at fishponds that they own in groups with other farmers (Wuyep and Rampedi, 2018).

3.6 Social Participation and Membership to Farmers' Group(s)/ Cooperatives and Aquaculture Association of Kenya (AAK)

Few of the fish farmers represented by 35.00 % (n = 134) are leaders in various capacities in the community. 76.70 % (n = 294) of the fish farmers belonged to farmers' groups and/ or fish cooperative societies and 89.11 % (n = 20) of these groups and cooperative societies either wholly or partially promote fish farming activities. There are 9 fish farmers' cooperatives in Kakamega County. These include the Kakamega Fish Farmers Cooperative Society and Khwisero Fish Farmers Cooperative Society. Kakamega Fish Farmers Cooperative has 498 fish farmers. Khwisero Fish Farmers Cooperative has 27 fish farmers registered with Kakamega Fish Farmers Cooperative. Kakamega County has about 500 fish farmers being members of the Aquaculture Association of Kenya (AAK).

A Chi-square test ($\chi^2_{1,\ 0.05}$ = 34.4, p = 0.022) of association showed there was a significant ($p < 0.05$) relationship between the fish farmers' membership to farmers' groups, cooperatives and Aquaculture Association of Kenya (AAK) and access to extension services. This implies that fish farmers who are members of fish farmers' groups and cooperatives are more likely to receive technical assistance and other extension services through the groups or cooperatives.

It was observed that fish farmers can also get extension services during social events such as Agriculture Shows of Kenya (ASK). During the ASK in 2017, there were various demonstrations and teachings in fish farming. These included how to set up a PVC-lined fishpond (Plate 1).

A Key Informant Interview (KII) with the Director Fisheries at the Kakamega County Department of Fisheries said that the Ministry of Agriculture, Livestock, Fisheries, Cooperatives and Irrigation (MoALFCI) has a demand-driven extension kind of agricultural extension. Fish farmers access extension services MoALFCI and from other fish farmers and from project extension officers of projects that promote aquaculture in the area.

These results are similar to the findings by Kiragu and Flohr (2016) that membership to groups and other farmer organizations offers the farmer an opportunity to benefit from the extension services that come through the groups and organizations. Membership in farmer associations enables the farmer to benefit from innovations and easily access to inputs (Nzevu *et al.*, 2018*)*.

Plate 1: A temporary demonstration of a PVC-lined fishpond at the Kakamega County Fisheries Department stand at Kakamega ASK showground

Source: Researcher (2017)

Most of the extension service providers allied to donor-funded projects in Western Kenya reach out to farmers through groups (Kiragu and Flohr, 2016). This makes it easier for farmers who are members of groups and/ or cooperative societies to access these extension services. The advantage of groups is that there is the easy mobilization of resources and labour and easy access to technical and financial assistance (GOK, 2010a)

3.7 Education Level

Fish farmers and fish farm managers who have formal education dominate fish farming in Kakamega County. According to Figure 1, most of the fish farmers represented by 52.04 % (n = 104) of the fish farmers interviewed and most of the fish farm managers represented by 56.55 % (n = 103) had attained formal education to the level of form four Kenya Certificate of Secondary Education (KCSE) respectively.

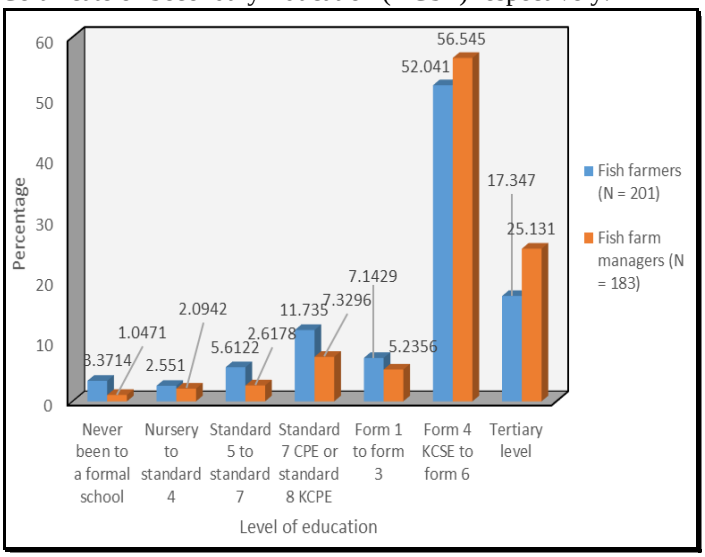

Figure 1: Education levels of fish farmers and fish farm managers in Kakamega County, Kenya

Source: Researcher (2018)

Very few fish farmers and fish farm managers represented by 3.57 % (n = 7) and 1.05 % (n = 1) respectively said that they have never been to a formal school. There is a

significant ($p < 0.05$) positive correlation between the level of education of the fish farmers and the average yield of fish per hectare ($r = 0.673 \pm 0.15$) and between the level of education of the fish farm managers and the average yield of fish per hectare ($r = 0.876 \pm 0.19$). This implies that education enables fish farmers and fish farm managers to easily understand the technical requirements of fish farming and easily apply appropriate innovations and new techniques in the fish value chain. Similarly, there is a non-significant ($p > 0.05$) positive correlation between the level of education of fish farmers and access to credits ($r = 0.567 \pm 0.22$). This implies that educated farmers can easily appreciate credits and easily access them, and can comprehend policy measures for sustainable fish farming.

It was observed that some fish farmers and fish farm managers had certificates in short courses related to fish farming and still others had diplomas and degrees in courses related to fish farming, farm management and agriculture. Similarly, some others reported having attended seminars, workshops and other fora covering matters related to fish farming. These farmers said that because of these academic backgrounds, short courses and seminars, they have been enlightened about fish farming and this has enabled them to improve their fish farming.

These results are similar to the results by Amankwah *et al.* (2018) that an increase in the education level of fi.sh farmers increases the yield of fish from the farms. Being more educated gives a farmer the advantage in understanding improved farming practices with ease and besides, is the accesses to valuable information for effective farm management that will help them increase output and income (Omoregbee *et al.*, 2013). Bosma *et al.* (2012) identified farmer's education and training level as one of the driving factors for adoption of innovations and found out that the level of knowledge on the sub-systems rice and fish was also higher for adopters. Ike and Chuks-Okonta (2014) also point out that education is a necessary tool in aquaculture practices as it affects output.

3.8 Household Income Distribution and Expenditure Pattern

The households' average annual income from fish farming is not a true reflection of the households' average total annual income. Therefore, the two were analyzed separately.

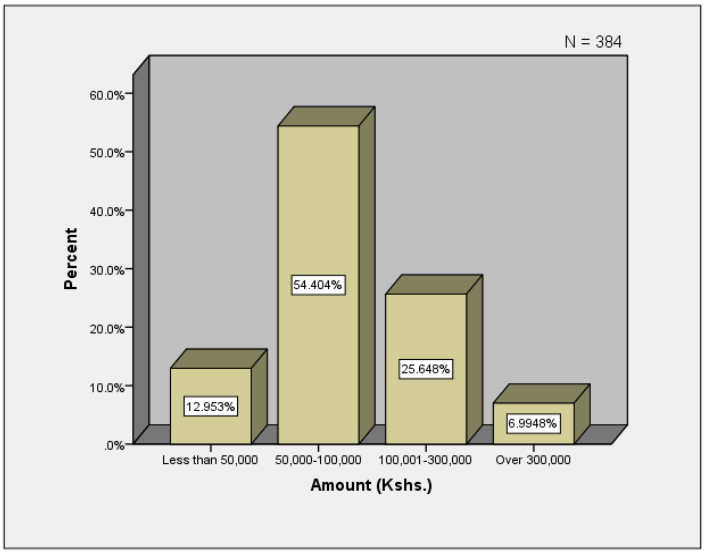

Figure 2: Distribution of the average annual income of fish farming households in Kakamega County, Kenya

Source: Researcher (2018)

Figure 2 presents the distribution of fish farming households' average total annual income. Many of the fish farming households represented by 54.40 % (n = 208) have their average annual income between USD 495.54 and USD 991.08 followed by 25.65 % (n = 98) of the fish farmers whose household average annual income is between USD 991.09 and USD 2,973.24. Fish farmers whose household average annual income is below USD 495.54 and those whose household average annual income is over USD 2,973.24 represent 12.95 % (n = 49) and 6.99 % (n = 26) respectively.

Figure 3 presents the distribution of fish farming households' average annual income from fish farming. Many of the fish farming households represented by 50.65 % (n = 194) have their average annual income from fish farming below USD 495.54. Those with average annual income from fish farming between USD 495.54 and USD 991.08, USD 991.09 and USD 2,973.24 and over USD 2,973.24 represent 22.74 % (n = 87), 13.70 % (n = 52) and 12.92 % (n = 49) respectively. When it comes to the expenditure of the household income, majority of the fish farming households represented by 72.61 % (n = 278) spend more than ¾ of their household income on meeting the household's expenses that do not relate to fish farming.

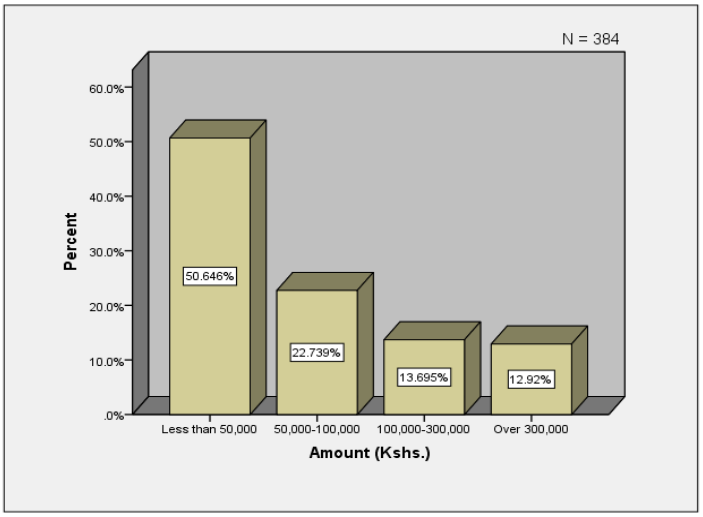

Figure 3: Distribution of fish farming households' average net annual income from fish farming in Kakamega County, Kenya

Source: Researcher (2018)

Another 11.89 % (n = 45), 13.70 % (n = 52) and 1.81 % (n = 6) of the farmers spend between more than ½ to 3/ 4, between more than ¼ to ½ and less than ¼ of their household income on meeting the household's expenses that are not related to fish farming respectively. Figure 4 presents the distribution of household expenditure as a fraction of the household's average annual income.

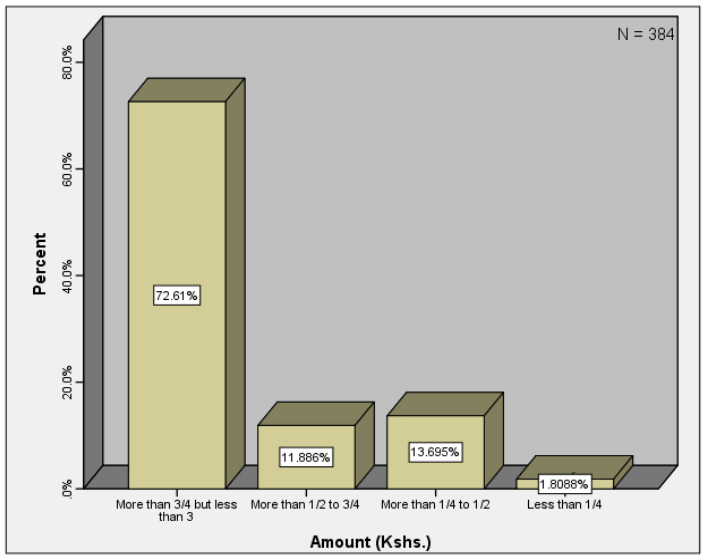

Figure 4: Expenditure as a fraction of the average annual income of fish farming households in Kakamega County, Kenya

Source: Researcher (2018)

Contrary to the above results, majority of the fish farming households represented by 82.95 % (n = 318) spend less than ¼ of their household income in upgrading their fishponds and meeting expenses incurred in fish farming. Another 8.79 % (n = 33), 6.20 % (n = 23) and 2.07 % (n = 7) of the farmers spend between more than ¼ to ½, between more than ½ to ¾ and more than ¾ of their household income in upgrading their fishponds and meeting expenses incurred in fish farming respectively. Figure 5 presents these results.

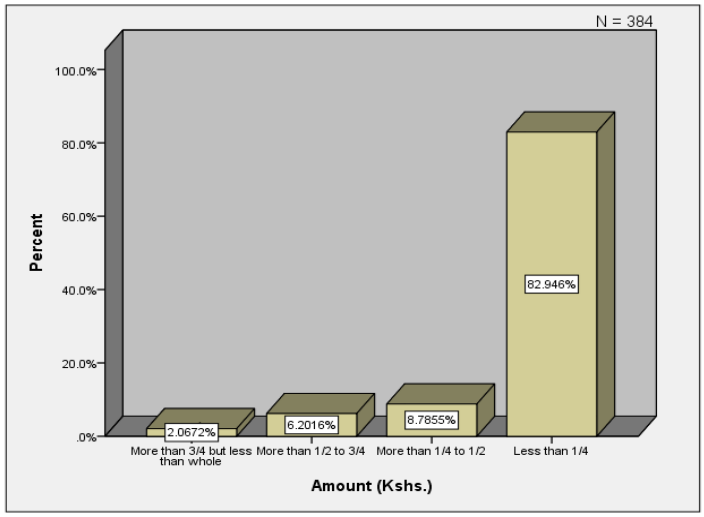

Figure 5: Investment in upgrading fish farming as a fraction of the average annual income of fish farming households in Kakamega County, Kenya

Source: Researcher (2018)

There was no correlation between the amount of average annual income of a household and the average fish yield per hectare. This means that the amount of average annual income of a household cannot precisely determine the success of a fish farming enterprise by that household because of other factors such as the expenses of the household that this income must meet and the distribution pattern of the income as it gets into the household.

However, a Chi-square test ($\chi^2_{3,\,0.05} = 67.4$, $p = 0.032$) of association showed that household investment in fish farming as a fraction of the household's average annual income and the average fish yield of fish per hectare are significantly ($p < 0.05$) related. This implies that the average fish yield per hectare is dependent on the amount of investment that the fish farmer or household uses to improve the fish farming enterprise.

These results connote the findings by Agbei *et al.* (2016) that a higher income is a motivational driver for the adoption of fish farming as a good part of the income is invested in fish farming without the worry of sacrificing other financial needs. Nguka *et al.* (2017) also found out that households with high incomes have no worry about investing in fish farming because of the availability of finances. However, this study presents the fact that it is not the amount of income of the household that determines the success of their fish farming enterprises but how much of the household income that is used to improve fish farming.

3.9 Occupations of Fish Farmers

Fish farmers had varied reasons as to why they started fish farming. It is clear from Figure 6 that majority of the fish farmers represented by 67.44 % (n = 258) started fish farming as a source of income either as the main source of income or as a supplement to other sources of income. These are followed by 26.62 % (n = 102) of the fish farmers who said that they opted to do fish farming because there was no other use for the land where they were doing fish farming. Other farmers representing 2.84 % (n = 10), 2.33 % (n = 8) and 0.78 % (n = 2) said that they started fish farming as a source of food, to manage the environment and for prestige, respectively.

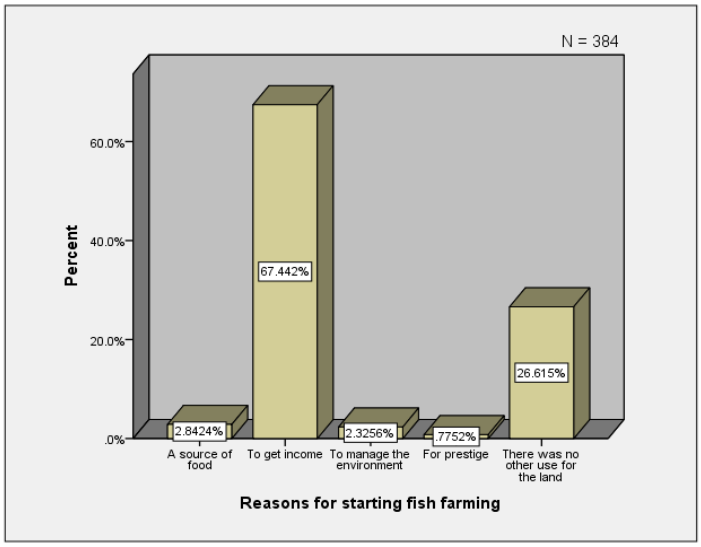

Figure 6: Reasons for starting fish farming by fish farmers in Kakamega County, Kenya

Source: Researcher (2018)

All farmers interviewed had at least one or more of other occupations like permanent employment, business, consultancies and other farming enterprises that they do alongside fish farming. However, fish farming is the main occupation and therefore the main source of income for 7.50 %

(n = 28) of the fish farming households. Other farming enterprises as the main source of income in the household had the highest score of 39.60 % (n = 152), followed by other undefined occupations with 23.90 % (n = 91), then formal employment with 22.50 % (n = 86) and lastly businesses with 14.00 % (n = 53).

A Chi-square test ($\chi^2_{3,\ 0.05}$ = 21.4, p = 0.043) of association showed there was a significant (p < 0.05) relationship between the integration of fish farming and other occupations including crop and livestock farming and the fraction of the households' income that is ploughed back into fish farming. This implies that fish farmers who have integrated fish farming and other occupations are more likely to plough back into fish farming much of their net household income. In an interview with one of the fish farmers (Participant 3 from Khwisero, July 6, 2017) she stated that:

> "Some of these fish farmers enter into the business of fish farming because they see other farmers also practising fish farming. Most of these are the ones who face challenges in management."

It was observed from the farms that all the households had integrated fish farming with other farming enterprises. A Key Informant Interview (KII) with the Chairman of Kakamega County Fish Farming Cooperative pointed out that the society encourages its fish farmers to integrate fish farming with other farming enterprises as a way of boosting their household income and as a shock absorber when one enterprise fails, thus taking the advantage of diversification.

This result collaborates the findings by Aurangozeb (2019) that the more enterprises a farmer has at the farm the more production the farmer is likely to get from the individual enterprises because of the large pool of income from the enterprises that are available for improving the farm. The integration of fish farming with other occupations has the advantage of enabling the farmers to create other incomes from a pool of "income-making engagements" which often is economic security that enables the farmers to minimize risks of enterprise collapse at the farm level (Badjeck, 2004). Abiona *et al.*, (2011) however argue that having many farming enterprises on the same small piece of land is associated with keeping the enterprises at small-scale and that the many enterprises divide the farmers' attentions making the farmer non-specialized.

3.10 Consumption of Fish

Most of the fish farming households consume fish. Many of them represented by 54.00 % (n = 207) take fish regularly and at least twice a week including fish harvested from their fish farms. These households have financial capability and, therefore, can afford fish when they need it. In addition, these households do not primarily do fish farming as a source of income but also for subsistence consumption. Another 43.90 % (n = 168) take fish but not regularly and sometimes with several days in between successive days of taking fish. These households have limited financial capability and, therefore, cannot always afford fish when they need it.

In addition, these households mainly do fish farming as a source of income and may eat the fish at harvesting. Another 2.10 % (n = 8) of the fish farming households do not consume fish because of reasons that were not disclosed during the research. The researcher alleges that these could be cultural or religious reasons. Fish farming is, therefore, a household source of food and an economic livelihood activity.

A Chi-square test ($\chi^2_{2,\ 0.05}$ = 17.9, p = 0.041) of association showed there was a significant (p < 0.05) relationship between the consumption of fish and the average yield per hectare. This implies that consumption of fish by a fish farming household has an influence on fish production at the household's fish farm. In an interview with one of the fish farmers (Participant 4 from Lugari, July 13, 2017), she stated that:

> "I am a fish farmer and I also ensure that my family appreciates the value of fish. I therefore not only rear the fish for income but I also ensure that the people in my household consume part of the fish harvested from my farm. This often gives me the encouragement and assurance that what I am doing is very important."

An interaction with fish traders on the markets of Kakamega Town reveals that much of the fish consumed in Kakamega County comes from other areas such as Busia, Kisumu, Uganda and Turkana. A fish farmer or fish farm manager whose family consumes fish appreciates the value of fish and, therefore, will have no reservations in investing in the enterprise and managing the same since he/ she has a positive attitude towards the fish (Osondu and Ijioma, 2014). Upadhyay *et al.*, (2014) reinforces that the study of consumer behaviour for fish with respect to consumers' taste, preference, food habits, family income and consumption expenditure on fish and related commodity is essentially important from its production, processing and marketing point of view.

4.0 CONCLUSION AND RECOMMENDATION

Demographic and socio-economic characteristics of fish farmers in Kakamega County affect the application of fish farming management practices and hence the adoption of best practices in fish farming management, which leads to successful fish farming. Demographic and socio-economic characteristics of fish farmers involve the interactions of people and psychological and situational factors and therefore determine investment patterns in the fisheries sub-sector, influence fish farmers' response to changes in technology and affect participation in aquaculture development. Therefore, they have an influence on the designing and successful implementation of a government's development programmes.

There is need to strengthen the capacity of fish farmers irrespective of their demographic and socio-economic status and promote an overall enabling environment in order to increase their response to technological changes and participation in development in fish farming.

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