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Factors Influencing Aquaculture Post-Harvest Interventions in Kisumu West Constituency, Kenya

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Abstract

Food and nutrition insecurity is a concern for the Kenyan government. As a result, various policy interventions have over time been implemented to deal with food and nutrition challenges within the country. Economic Stimulus program is one such intervention with specific objectives to create employment opportunities, improve nutritional status of the constituents and contribute towards rural development across the 140 selected constituencies, Kisumu West Constituency being amongst them. Despite the significant investment of resources by government, small holder aquaculture production showed a decline both nationally and within the area of study. Production within area of study was below the national average despite having suitable conditions alongside farmers being trained and capacity built on pond management skills. This awakened the necessity to determine the factors influencing post-harvest interventions in Kisumu West constituency. The study results could inform stakeholders as agents to come up with appropriate corrective measures to address the emerging post-harvest issues affecting aquaculture performance. A total of 389 farmers were administered with questionnaires in person, through the snowball sampling method from a population of 417 farmers. A descriptive research design was employed through a survey to collect both quantitative and qualitative data. Primary data was collected using questionnaire, key informant interviews and observation. Secondary data was collected from peer-reviewed publications, and journals. Quantitative data generated frequency tables, then analyzed to percentages, mean, Chi-square, and Pearson's correlation coefficient between the variables. Qualitative data was coded to create themes and categories. Thematic analysis was done for themes and contingency tables developed for categories. The analyzed results were then presented using text, tables, pictorials and

graphs. Personal-financed farms experienced better production levels and fewer dropout rates compared to those funded by the government. Though farmers were trained on post-harvest intervention skills at the initiation stage, subsequent training and capacity building by extension officers were not satisfactorily done to ensure farmer acquisition of the required skills. At 0.05 confidence level, the Chi-square values on farm status and cold storage, funds to restock, sourcing for the market, and value addition evidenced dependence, directly affecting fish pricing. The study recommends the establishment of the best management practice and capacity-building on post-harvest management skills, and the creation of improved marketing infrastructure for the farmers. The County Government should increase budgetary allocation for aquaculture and enlist extension officers for in-service training on aquaculture professional development and capacity building. The study results would be beneficial to planners and policy makers for management and implementation of future projects and interventions.

Keywords

Aquaculture, Post Harvest Interventions, Value Addition

1. Introduction

The Food and Agriculture Organization (FAO) has estimated that more than 30% of all fish used for human consumption originate from Aquaculture. In 2010, the world aquaculture production was 60 million tons of fish and crustaceans, and 20 million tons of aquatic plants (FAO, 2012). For comparison, capture fisheries provided 90 million tons, that is, the share from aquaculture was about 47% of the total aquatic production while excluding aquatic plants, the share from fish and crustaceans was about 35%. The world's human consumption was estimated to be about 18 kg per capita per year. Globally, aquaculture is the fastest-growing food producing sector. Outpacing population growth, that is the global production of fish, crustaceans, and aquatic plants increased by about 5% per year from 2001 to 2010 (FAO, 2012). As evidenced, the high consumption rate of fish products provides valuable market for aquaculture products globally.

Thant (2018), aquaculture in Myanmar has grown rapidly in the last decade and plays an important role in the national fish supply. Aquaculture production had reported slightly over one million tons in 2016 which is around a 2 percent increase from the previous year. The growth was sustained due to the proper handling of fish post-harvest to realize maximum income for the farmer. The study indicates the importance of post-harvest interventions, therefore, there is a need to find out if similar initiatives were put in place by Kenyan farmers to attain commercialized farms. Adrien (2015), in an attempt to promote sustainable small-scale fisheries in the context of food security and poverty eradication in

Kenya, numerous post-harvest management interventions have been made by the government, development partners, and stakeholders. The study would establish if such interventions were cascaded to support pond farmers in the Kisumu West constituency, in the spirit of realization of commercialized farms.

Macharia and Njagi (2020) elucidate that in Kenya major challenges of fish post-harvest handling include lack of infrastructure at the farms for fish preservation, lack of nearby markets, and the remoteness of the production areas, in most of the scenarios fish drying often occurs on the bare ground where the product is exposed to soil, bacteria and birds and poor market linkages between production and marketing sites. The challenges expose the lack of sufficient skills by the farmers to suitably handle fish after harvest leading to losses. Harvesting and proper handling of fish post-harvest determine the amount of income that a farmer would earn. Though there is high demand for fish products. The availability of cold storage facility at the farm and a value addition program was of great importance to allow minimization of fish loss after harvest. The findings by Macharia and Njagi (2020) informed on the importance of commercializing post-harvest practices. This would serve to avert the fish losses through value addition, processing, and instituting astute marketing skills. The main objectives of value chain management are to maximize profit and ensure long-term sustainability. This study was therefore focused on establishing the relationship between farm activity and farmer integration of business-oriented post-harvest practices. The effect of the commercialized post-harvest practices on the income earned by the farmer and establishes the challenges faced by the farmer in the process.

2. Literature Review

Akande and Diei (2010) pose that it has been estimated that 10 percent of world fish caught by weight is lost through poor handling process, storage and distribution. However, losses in small-scale fish processing are said to be particularly high. Similar losses may be attributed to the current area of study. However, Akande and Diei (2010) in their study do not clearly spell out the specific government interventions put in place to support the small sale farmers to minimize the fish loss post-harvest. According to Kolding et al. (2016), studies done in some sub-Saharan countries (Ghana, Kenya, Mali, Tanzania and Uganda) show that substantial losses in small-scale fisheries occur at all stages after harvest including during distribution and utilization from capture to consumption.

Tesfay and Tefers (2017), classify post-harvest losses as either nutritive or economic losses that render fish unavailable or nutritionally deficient for human use. Thant (2018), explains that as soon as fish dies spoilage begins. The body becomes stiff and rigid caused by rigor mortis within the first seven hours. The study further classifies post-harvest losses into five categories nutritive loss that included discard of fish after harvest due to spoilage or bad handling which could lead to loss of its nutritional value during storage or lower economic re-

turns because of its low price. Physical losses are the wasting or throwing out of fish after harvesting or landing. Quality loss relates to fish that has undergone changes due to spoilage or physical damage and has suffered quality deterioration. Economic losses are the result of the changes in market demands due to oversupply or lower demand. Processing losses are the result of using improper techniques in traditional fish processing that might give negative impacts on the nutritional value of fishes.

In order to avert the fish losses value addition should be undertaken through processing and instituting astute marketing skills. According to FAO (2015a), the perishable nature of fish requires special attention to handling, grading and packing and the market price is usually dependent upon the quality of the fish. Market considerations differ from country to country, region to region and have close connections with food habits and consumption patterns. The main objectives of value chain management are to maximize profit and long-term sustainability. Fish can be sold in many forms with the simplest form as whole fresh fish. It can be processed further to either increase the appeal of the product or increase the shelf life. Some techniques are based on temperature control that includes icing the fish, refrigeration or freezing. Other techniques involve the removal of water from fish and include drying, smoking and salting FAO (2015b) fermenting fish, fish canning, vacuum sealing and cooking through frying, boiling and baking. The choice of value addition method depends on available processing materials and sources of energy, the storage facilities and the costs of each method as well as the tradition and the market demand.

FAO (2015b) note that marketing is about understanding your customers' buying habits and persuading them to buy your products rather than those of the competition. It involves identifying, anticipating, satisfying and even exceeding your customer's needs. Marketing includes finding out what customers want, producing a product that meets their needs, pricing the product appropriately, distributing where the customers are located and promoting through appropriate advertising. As part of the planning process the farmer is expected to market the product in advance to be sure of the market before the harvesting day. Hishamunda et al. (2017) state that a market plan should be composed of two sections: the market analysis and the market strategy. The marketing plan should identify among other things the distance between markets and the fish farms, the markets accessibility, the transportation costs, the frequency and scheduling of deliveries, the volume and size requirements of the market, the historical prices paid. Bueno and Pongthanapanic (2014) enumerate that good market analysis informs good production and marketing strategies by keeping up to date on market information enables the farmer to negotiate fair and uniform price, the reputation of product and farm improves market access and competitiveness and avoid direct completion for instance harvesting when the wild-caught fish harvest is scarce. After an astute marketing plan is laid out then the farmer should be in a position to price the fish products well.

According to Hishamunda et al. (2017) prices are determined by the interaction of supply and demand in competitive markets. When determining the price of aquaculture products farmers have to cover the costs of production at the very least, aim to generate a profit and, at the same time set a price which consumers are willing to pay. The important consideration for a farmer should be that for a given quantity of fish harvested the break-even price above total cost (BPTC) given by $=\frac{TC}{Q}$, should be the minimum selling price without making any profit. Proper pricing, therefore, is an important component in commercializing aquaculture and this study assessed if the farmers enlisted under ESP were taken through sufficient training.

FAO (2015b) there are many organizations in fisheries and aquaculture. Some are formed to represent groups of fishers to have a voice in management decisions, market products together and serve as joint production and distribution centers. Advantages of working together, being stronger, more visible and having a voice increase bargaining power. Rutaisire et al. (2009) effective organizations that can link producers with markets will be needed if aquaculture is to grow and produce enough farmed fish to meet the current and future demand for fish. Such producer organizations can develop systems for transportation to markets, the sale of the produce from the farms, and information sharing and gathering among members. The existence of such organizations was sought during the current research to ascertain their support during training and capacity building of the farmers, provision of sufficient market and commensurate fish prices for the fish produced within the area of study.

According to Schut et al. (2015), Agricultural Innovation Systems (AIS) approach, innovation perceived as a process of combined technological (e.g in fisheries: cold chain infrastructure, processing equipment and non-technological changes. The changes occur across different levels and are shaped by interactions between stakeholders and organizations inside and outside the sector. This emphasizes the need for a better understanding of the drivers of post-harvest innovation and the identification of entry points for the innovation to overcome reported losses.

Munguti et al. (2021) and Molla (2021) posit that failure to secure direct markets leads to fish spoilage and low prices. To maximize the available financial and market opportunities fish traders (mostly women) can be organized into groups to attract funding. The opportunities created by changing eating habits where more people are now eating fish, the youth can also venture and explore opportunities in value-added product development and introduce the developed products into the markets. Examples of these products and commercial importance include fish fillets, fish balls, fish fingers, sausages, and fish gel from fish scales (used in pharmaceutical and cosmetic industries). These are opportunities in training the youth on value-addition technologies and the fabrication of value-addition equipment. Opportunities also exist in modern fish processing technologies and mar-

keting techniques and platforms.

3. Research Methodology

A research design is a set of methods and procedures that have been created to find answers to research questions. During the study, descriptive research design was used. According to Bhattacherjee (2012), descriptive research is directed towards making careful observations and detailed documentation of a phenomenon of interest. These observations must be based on the scientific method and therefore are more reliable than casual observations of untrained people. Kumar (2011), further states that descriptive study attempts to describe systematically a situation, phenomenon, problem, service or program or provides information about say the living conditions of a community or describes the attitude towards the issue.

In order to achieve these results a method of survey research is applied for efficient data collection. According to McCombes (2023), survey research is a quantitative research method used for collecting data from a set of respondents. Survey research is implemented by researchers in cases where there is a limited cost involved and there is need to access details easily. The research design best suits the study in which a lot of insightful information was to be collected from the farmers. Use of survey in data collection was of great importance based on its flexibility to use non-probability sampling methods like snowballing.

This study was geared towards determining post-harvest interventions on income earned on aquaculture projects within the area of study. The survey focused on farmers who were engaged in aquaculture in Kisumu West Constituency. The farmers who were not actively engaged in aquaculture formed an integral part of the study in getting the perspective of why certain farmers dropped out of the ESP, if there were management challenges. The collected data was utilized based post-harvest interventions in aquaculture. Comparisons were derived on the level of attainment of the requisite skills and performance of the farms depending on the source of funds.

Questionnaire, observation and key informant interviews were used to collect data during the study from the respondents. The data collected was both qualitative and quantitative in nature. The collected data was such that they could reliably and validly address the specific objectives of the study. The collected data were coded to enable data analysis for both quantitative and qualitative data. The qualitative data was analyzed to present patterns and categories. Quantitative data on the other hand were analyzed using percentages, Pearson's correlation coefficient, Chi-square and cross-tabulation.

3.1. Area of Study

Kisumu West Constituency was formed from Kisumu Town West and Kisumu Rural Constituencies. Kisumu West Constituency is strategically located and borders Kisumu Central Constituency to the South East, Kisumu East Constitu-

ency to the East and North East, Seme Constituency to the West, Vihiga County to the North and Lake Victoria to the South. The Constituency has an estimated population of 131,246 residents with an estimated area of 358.7 square Kilometres. It has five wards, namely Central Kisumu, North West Kisumu, West Kisumu, South West Kisumu and North Kisumu. Though cosmopolitan, the main spoken languages are Dholuo, Kiswahili and English. The topography is undulating with seasonal streams meandering through the plain land and hills towards Lake Victoria. The major economic activities in the area include small, medium and micro business enterprises, subsistence agriculture, livestock farming and commercial residential housing.

3.2. Sampling and Sample Frame

Ben-Shlomo et al. (2013) state that snowballing sampling is commonly used in social science when a sampling frame is difficult to get. Existing subjects are asked to nominate further subjects known to them as such, the sample increases in size like a rolling snowball. The sample frame (**Table 1**) for the farmers in Kisumu West Constituency was difficult to get since only a few contacts o the farmers were provided at the Kisumu West sub-county fisheries office during the pre-study visit. Based on this, the interviews were carried out starting with farmers, who could be engaged through the contacts provided by the fisheries office. Once a farmer was taken through the questionnaire, they were probing was done to get contacts and locations of other farmers they knew to be active or had practiced aquaculture before.

4. Results and Discussions

4.1. Introduction

This section addresses the evaluation of the effects of post-harvest interventions on income earned from aquaculture in Kisumu West Constituency. Aquaculture as an agribusiness should enable farmers earn sufficient income. This involves instituting a business approach to post-harvest management skills to reduce fish losses after harvest. Tesfay and Tefers (2017), define post-harvest losses as nutrient or economic losses that render fish unavailable or nutritionally deficient

Table 1. Sampling frame.

Ward	Registered Farmers	Sampled Farmers	Percentage of sampled Farmers
Central Kisumu	25	23	5.9%
Kisumu North	223	217	55.8%
North West Kisumu	63	57	14.6%
South West Kisumu	55	49	12.6%
West Kisumu	51	43	11.1%
TOTAL	417	389	100%

Source of Data: Kisumu West Sub County Fisheries Office.

for human use. Commercialized farms should have sufficient capitation to sustain their operations, the fish produce should be competitive in the market, therefore, the post-harvest interventions put in place should be beneficial to the farmer. For the interventions to be applied the farm should have been actively in production. This was analyzed through the effect of the interventions on the current farm activity status. The indicators of post-harvest interventions included the records kept by the farmer, value addition tools and equipment available at the farm, availability of storage facilities and the farmer's ability to price fish products.

4.2. Pricing of Fish Produce

The study sought to establish if the price of fish at the fish band as along the lake shore had a significant contribution towards the pricing of fish after harvest. This also served to underscore the pricing methods used by the farmers in pricing the fish harvested at the farm. More than half of the farmers inquired about the cost of fish at the fish band as along the lake before pricing the fish after harvesting. However, in 49.44% of the farms pricing was not dependent on the lake shore prices. On further interrogation of the farmers, it was noted that though they do not depend on lake shore prices their selling price could be lower than the lake catches due to the need to sell the harvest fast. The residents also believe that fish raised from the ponds are less nutritious compared to those from the lake. The fishmongers who purchase in bulk also determine the fish prices due to the low purchasing power of the locals.

Table 2 shows that 58.4% sold fish at the farm, that is 0 Km. It was further noted that 56.37% never sourced for a market before harvesting while 43.63% sourced for market before. The respondents who sourced for the market and informed prospective buyers in advance sold the fish and made good returns from the sale. For a market distance of 1 Km, there were 15.6% of the farms of which 64.84% sourced for the market and 35.16% did not look for a market for the produce. The respondent noted that the distance did not have a substantial effect on the net income.

For a market distance of up to 2 Km, 10.4% of the farms were in existence, of which 86.72% sourced for the market before harvesting while 13.28% did not. At a market distance of about 5 Km 14.3% of the farms was represented of which

Table 2. Distance from market and sourcing patterns of farmers.

Distance in Km	Number of Farms	% of total number of farms	No of farmers sourcing for market	% sourcing for market
0	227	58.4	167	43.6
1	61	15.6	252	64.8
5	56	14.3	375	96.3
10	5	1.3	378	97.2
	389	100		

96.3% sourced for the market, yet 3.7% did not. Finally, for a distance of about 10 Km, 1.3% of the farms were represented and 97.2 sought the market before harvesting while 2.8% did not. From the trend it can be noted that the further the market was from the farm, a maximum of 97% of the farmers sourced for the market for the produce, the distribution of the market within the constituency is captured on the map on Figure 1. Some of the farmers did not depend on the locals to make the purchases and looked for established fish mongers or hotels to make the sales. This improved the profit margins as some made purchases in terms of weight as opposed to selling per piece.

A Pearson's Chi-Square analysis was done between the current status of the farms with fish size met, availability of cold storage facility at the farm, ability to restock the farm after harvest, sourcing for a market of the produce before harvesting, taking into consideration distance of the farm from the market while pricing and value addition on fish harvested. Table 3 provides a summary of the analysis done.

Table 3 provides results attained on factors put into consideration during pricing of fish after harvest. 26.5% (n = 103) of the farmers (active) met the fish size required during harvest, 21.6% (n = 84) did not meet the requisite fish sizes. The active farmers attained a chi-square value of 1.3, a critical value 3.841 at 0.05 confidence level. The status of the farm was independent of the pricing of fish through ability to meet the fish size. 24.4% (n = 95) of the farmers (not active) met the fish size required during harvest, 27.5% (n = 107) did not meet the requisite fish sizes. From the results the dropout farmers attained a chi-square value of 1.2, critical value 3.841 at 0.05 confidence level. The status of the farm was independent of pricing of fish through the ability to meet the fish size. Overall, 50.9% (n = 198) of the farmers met the fish size required during harvest, 49.1% (n = 191) did not meet the requisite fish sizes. A chi-square value of 2.5, critical value of 3.841 at 0.05 confidence level were attained. The status of the farm was therefore independent of establishing fish size through the size met during harvest. This is because fish is sold based on the sizes harvested.

On availability of cold storage facilities, 9.3% (n = 36) of the farmers (active) had cold storage facilities at the farm, 38.8% (n = 151) did not have the storage facility. 15.4% (n = 60) of the farmers (not active) had fish storage facilities, 36.5% (n = 142) did not have a fish storage facility. Overall, 24.7% (n = 96) of the farmers had cold storage facilities at their farms, and 75.3% (n = 293) did not have a cold storage facility. The result indicated that very few farmers had cold storage facilities at the farms to ensure preservation of fish after harvest. This calls for the urgent sale of the product immediately after harvest to minimize losses. A chi-square value of 5.7, critical value of 3.841 at 0.05 confidence level were attained, an indicator that the status of the farm and pricing of fish are dependent on the farmer having a cold storage facility. In light of the above, it is prudent that farmers invest on cold storage facilities to provide sufficient time to negotiate for better pricing of the fish harvested.

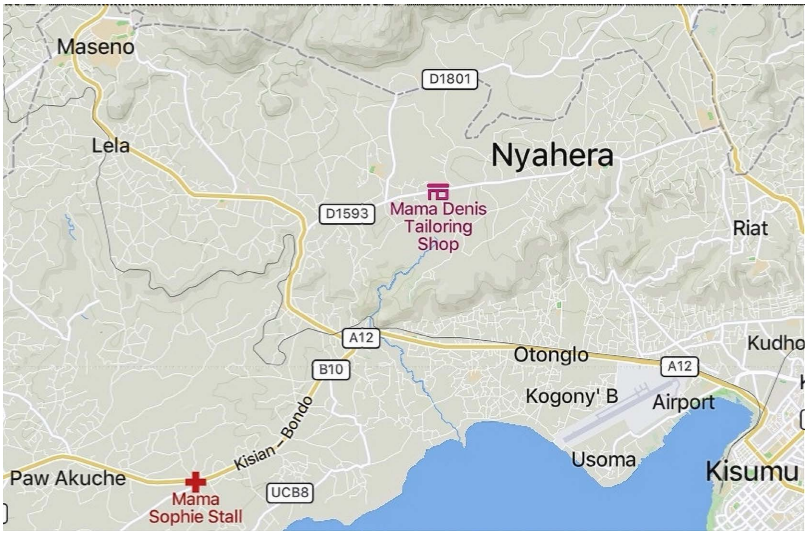

Figure 1. Map showing the location of Kisumu West Constituency (Source: Mapcarta.com).

Table 3. Relationship between farm status and post harvest pricing interventions.

Status	Post Harvest Interventions								
	Fish size Met			Cold Storage			Funds to restock		
ACTIVE	84	103	187	151	36	187	41	146	187
Expected frequency	91.8	95.2	187.0	140.9	46.1	187.0	64.4	122.6	187
Chi 2 value	**0.7**	**0.6**	**1.3**	**0.7**	**2.2**	**3.0**	**8.5**	**4.5**	**13.0**
Cell %	**21.6**	**26.5**	**48.1**	**38.8**	**9.3**	**48.1**	**10.6**	**37.5**	**48.1**
NOT ACTIVE	107	95	202	142	60	202	93	109	202
Expected frequency	99.2	102.8	202.0	152.1	49.9	202.0	69.6	132.4	202.0
Chi 2 value	**0.6**	**0.6**	**1.2**	**0.7**	**2.1**	**2.8**	**7.9**	**4.1**	**12.0**
Cell%	**27.5**	**24.4**	**51.9**	**36.5**	**15.4**	**51.9**	**23.9**	**28.0**	**51.9**
TOTAL	191	198	389	293	96	389	134	255	389
Expected frequency	191.0	198.0	389.0	293.0	96.0	389.0	134.0	255.0	389.0
Chi 2 value	**1.3**	**1.2**	**2.5**	**1.4**	**4.3**	**5.7**	**16.4**	**8.6**	**25.0**
Cell %	**49.1**	**50.9**	**100**	**75.3**	**24.7**	**100**	**34.4**	**65.6**	**100**

A higher percentage of farmers at 37.5% (n = 146) of the farmers (active) had set aside funds for restocking, compared to 28.0% (n = 109) of the drop out farmers who budgeted for funds to re-stock. It was also noted that a lower percentage of drop out farmers at 23.9% (n = 93) compared to those of active farmers at 28.0% (n = 109) did not budget for funds to re-stock their ponds after harvest. In total, the percentage of farmers who responded to have properly budgeted funds for restocking the ponds stood at 65.6% (n = 255) against 34.4% (n = 134) who did. A chi-square value of 25.0, critical value 3.841 at 0.05 confidence level were attained. An indicator of dependence of the status and continu-

ity of production at the farm have a proper budget and plan for funds to restock the farms after harvest.

From Table 4, 31.9% (n = 124) of the farmers (active) sourced for market for the fish before harvest while 16.2% (n = 63) did not source for market. The chi-square value for the active farmers was 4.3, critical value 3.841 at 0.05 confidence level. This showed dependence of status of the farms and setting fish prices to sourcing of its market before harvesting. 26.9% (n = 105), of the inactive farmers sourced for fish market while, 25.0% (n = 97) did not. The drop out farmers had a chi-square value of 4.0, critical value 3.841 at 0.05 confidence level. This also indicated dependence on the status of the farm on the sourcing for market during their time of activity. Overall, 58.9% (n = 229) farmers sourced for fish market before harvest while 41.1% (n = 160) of the farmers did not. The chi-square value for storage of fish was 8.2, critical value 3.841 at 0.05 confidence level.

This indicated dependence of the status of the farm and pricing of fish products to sourcing of its market before harvest. Market for products sourced in advance provides the farmer with the power to negotiate for prices, plan for the nature of value addition to be done on the product based on the buyer's needs, minimize on costs on storage after harvest in case few buyers are realized for the product.

Table 4. Relationship between Status of the farm and components of pricing and post-harvest interventions.

Status	Components of pricing and post Harvest Interventions								
	MARKET SOURCING			**DISTANCE TO MARKET**			**VALUE ADDITION**		
ACTIVE	FALSE	TRUE	TOT.	FALSE	TRUE	TOT.	FALSE	TRUE	TOT.
Expected frequency	63	124	187	110	77	187	182	5	187
Chi 2 value	76.9	110.1	187.0	104.8	82.2	187.0	172.6	14.4	187.0
Cell %	**2.5**	**1.8**	**4.3**	**0.3**	**0.3**	**0.6**	**0.5**	**6.2**	**6.7**
NOT ACTIVE	**16.2**	**31.9**	**48.1**	**28.3**	**19.8**	**48.1**	**46.8**	**1.3**	**48.1**
Expected frequency	97	105	202	108	94	202	177	25	202
Chi 2 value	83.1	118.9	202.0	113.2	88.8	202.0	186.4	15.6	202.0
Cell%	**2.3**	**1.6**	**4.0**	**0.2**	**0.3**	**0.5**	**0.5**	**5.7**	**6.2**
TOTAL	**25.0**	**26.9**	**51.9**	**27.7**	**24.2**	**51.9**	**45.5**	**6.4**	**51.9**
Expected frequency	160	229	389	218	171	389	359	30	389
Chi 2 value	160.0	229.0	389.0	218.0	171.0	389.0	359.0	30.0	389.0
Cell %	**4.8**	**3.4**	**8.2**	**0.5**	**0.6**	**1.1**	**1.0**	**11.9**	**12.8**
	41.1	**58.9**	**100**	**56.0**	**44.0**	**100**	**92.3**	**7.7**	**100**

A lower percentage of farmers at 19.8% (n = 77) of the farmers (active) were affected by distance from the market in terms of pricing, compared to 28.3% (n = 110) who were not affected by the distance. It was also noted that a lower percentage of dropout farmers at 24.2% (n = 94) compared to 27.7% (n = 108) were affected by the distance from the market. Entirely, the percentage of farmers who responded to have been affected by the distance from the market in pricing of the fish products stood at 44.0% (n = 171) against 56.0% (n = 218) who were not affected. A chi-square value of 1.1, critical value 3.841 at 0.05 confidence level were attained. An indicator of independence of the status and pricing of fish products. This was addressed through online marketing of products through (WhatsApp, Facebook), use of mobile calls to network and call known customers on availability of products, ease of transportation of fish using motorbikes that can easily access the rural areas at lower cost.

Value addition was another component of pricing that farmers were interviewed. 1.3% (n = 5), of the farmers (active) did value addition to fish while 46.8% (n = 182) did not do any value addition. The chi-square value for the active farmers was 6.7, critical value 3.841 at 0.05 confidence level. This was an indication of dependence of status of the farm and pricing of fish products to value addition after harvest. 6.4% (n = 25) of the farmers (inactive), did value addition, while 45.5% (n = 177) of the farmers did not. The chi-square value for the drop out farmers was 6.2, critical value 3.841 at 0.05 confidence level an indication of dependence of pricing to value addition. Overall, 7.7% (n = 30) of the farmers performed value addition, 92.3% (n = 359) did not. The chi-square value attained was 12.8, critical value 3.841 at 0.05 confidence level. This indicated dependence of status of the farms and pricing of fish product to performing value addition of the products after harvest. Most farmers however stated that due to the high demand for fresh fish products led them not to do value addition. The farmers who did value addition lacked storage facility for the product in order to minimize on loss of the harvested fish product through spoilage.

Research done by Adrien (2015) found out that the attempt to promote sustainable small-scale farmers in the context of food security and poverty eradication in Kenya, numerous post-harvest management interventions (innovations) have been made by government development partners and stakeholders. Nonetheless high post-harvest losses are still reported against the sectors framework in post-harvest management (innovations) aimed at reducing losses and in boosting food security and poverty eradication. Similar findings were found in the study that despite capacity building on value addition and use of cold storage facilities there was a significant drop on farm production levels.

The challenges enumerated by the farmers during the study concur with those of Macharia and Njagi (2020) who found out that in Kenya major challenges of fish post-harvest handling includes lack of infrastructure at the farms for fish preservation, lack of nearby markets and the remoteness of the production areas, in most of the scenarios fish drying often occurs on the bare ground where the

product is exposed to soil, bacteria and birds and poor market linkages between production and marketing sites. The study findings are in line with that of Kolding et al. (2016), done in some sub-Saharan countries (Ghana, Kenya, Mali, Tanzania and Uganda) which show that substantial losses in small-scale fisheries occur at all stages after harvest including during distribution and utilization from capture to consumption.

In light of this more emphasis should be placed on capacity building in post-harvest management of fish. Different stakeholders should come forward to fund the farmers in order to acquire cold storage facilities, and support in finding markets for value-added products as opposed to the current existing local market of fresh fish. From the study therefore, there is a need to adopt the views made by FAO (2015a), that the perishable nature of fish requires special attention to handling, grading and packing and the market price is usually dependent upon the quality of fish. Market considerations differ from country to country, region to region and have close connections with food habits and consumption patterns. The main objectives of value chain management are to maximize profit and long-term sustainability.

Intensive fish farming requires considerable financial and physical commitment. This therefore means that, farmers must adequately plan on how to market and set prices for the produce after about six to eight months of strict farm management. The major items that farmers were trained and capacity developed on as per the guidelines provided by ESP, were marketing for the product, setting up competitive prices from the product, proper storage of the produce and value addition of fish to enable the farmer to maximize the returns. The pricing of a product is determined by interaction of supply and demand in competitive markets. The cost of production must be recovered at the very least to make a profit (Hishamunda et al., 2017). In light of this that due consideration of competitors' price and in this case, the price of fish from the lake.

Hishamunda et al. (2017) further write that a good marketing plan should identify distance between markets, market accessibility, transportation costs and historical prices paid among other factors. Poor or selective implementation of these factors may have led to challenges faced by the farms during the harvest and selling of the produce. However, the findings from the farmers in Kisumu West constituency contradict distance from the farm to the market as a challenge leading to dropout in farming. The findings of the study are also contrary to a report by Chan (2019) on fish farming projects which state that most aquaculture farmers were adequately equipped with technical skills required for fish management, handling and storage. The training and refresher training was undertaken in collaboration with the Ministry of Education. A majority of the farmers also felt that field visits by the extension fisheries officer provided continuous technical know-how to farmers. The report summarizes that aquaculture as projected created employment and boosted income however, due to a lack of storage facilities for the harvested fish the venture did not turn out to be a

high-income earner as expected.

4.3. Post Harvest Management Skills vs Income Earned

The main objective for any business enterprise is for the entrepreneur to generate some income. ESP was established to jumpstart the economy from the low economic growth that was evidenced after the 2007/2008 post-election violence.

Table 5 shows the mode farmers who harvested their produce in the last one year preferred to sell the produce. 5.26% is priced per kg while 94.74 priced per piece. Pricing per piece was preferred by locals who buy the produce per piece based on size. Fishmongers who are also key players in the market made purchases based on size per piece than a measure in kilograms.

Based on the most utilized mode of selling the fish harvested, the following table provides a summary of earnings made from the venture by farmers in Kisumu West Constituency in the last year.

From Table 6 the lowest price charged per piece of fish was KES 5.00 and these were mainly sold in batches based on the size. The highly priced fish at the farm retailed for KES 450.00 per piece. About 37,970 pieces of fish harvested within the period netted a gross income of KES 5,741,800.00. This provided an average of KES 151.20 per piece. It can be observed that farms with sources of funding as personal finance earned an income almost twice as those financed through ESP and this could be attributed to better technical and post-harvest management skills. According to Mwatsuma et al. (2012) in relation to development of the enterprise in the world, fish culture has proved successful in improving standards of living of rural farmers in Asia, where fish culture has a long tradition. From the report, observations made in Asia and the relationships noted between the status of the farms and the various components of post-harvest management skills, if aquaculture is well managed then it is a profitable venture that could aid in the achievement of the objectives of Vision 2030.

Luntao (1990) states that any business large or small, public or private should maintain an efficient record-keeping system. All business transactions should be recorded in full on paper. Input records should include variable inputs or costs which vary with the level of production such as fingerlings, feeds, fertilizer, labour and pesticides. Output records should show detailed information on date of harvesting, species harvested (with their amount and unit price) and the disposition of the products. Gross revenue should include cash and credit sales of the products and the imputed values of the quantities consumed on the farm. Many businesses fail because of inadequate record-keeping.

Table 5. Preferred Mode of selling fish.

Mode of Selling	Number	Percentage	Total
Per Kg	4	5.26	5.26
Per Piece	74	94.74	94.74

Table 6. Income earned from pond farming.

Source of Capital	Income earned (KSH)
ESP	1,224,400
Personal Funds	2,875,500
SACCO/Group	812,500
ESP and Personal	824,400
Personal & Sacc/Group	5000
Total	5,741,800

Most of the farms visited had no records kept to show history and production trends at the farm over time. Based on this most of the farmers were not able to quantify the levels of profits or losses made. Some of the ESP-financed farms did not find a justification for the records since all the funding came from the government. The lack of trail of performance of the farms justifies the level of dropout and decline in the performance of the farms. In management perspective in the absence of the records, the extension officers and farm managers will be constrained to identify areas of challenge early and prescribe workable interventions. The study results are in line with that of Macharia and Njagi (2020) stating that in Kenya, the major challenges of post-harvest handling of fish include a lack of infrastructure at the farms for fish preservation, lack of markets and the remoteness of production areas. The results are in tandem with that of Rutaisire et al. (2009), who state that there exists need to create effective organizations that can link producers with markets for aquaculture to grow and meet current and future fish demands. The organization should develop systems and infrastructure for transportation to markets, sale of produce from the farms and information sharing and gathering among farmers.

5. Conclusion and Recommendation

Based on the findings and discussions if farmers managed aquaculture as business enterprises, it could afford employment opportunities and source of income to both youth and women in the rural areas. Both the National and County Governments can revamp the ESP established projects by ensuring that the farmers are clustered regionally into smallholder groups to facilitate ease of training and visit by extension officers. The groups can act as suitable avenues for marketing and value addition of the fish products. The production management skills if accurately implemented, then ESP-funded aquaculture will accomplish the core objective of improved economic status of the rural based entrepreneurs and consequently the country's economic growth.

The study has clearly shown the importance of farmer needs analysis done before project inception to ensure that sufficient resources are provided to sustain the venture. Clear relationships have been created on importance of farmer acquisition of pond management skills to ensure farms in rural areas attain

maximum productivity. There is need to improve on value addition and provision of cold storage facilities to pond farmers to improve farmers income. Farmers should be adequately trained on how to keep good business records to track expenses and income. Training should be done on fish pricing to ensure farmers maximize on profitability.

To commercialize aquaculture innovative post-harvest interventions should be put in place. This would support the farmers in pricing, marketing and performing value addition to the fish products. There should be engagement of various stakeholders to create external markets (export) of value-added fish products, fund purchase of cold storage facilities and provide capacity building on budgeting and planning for business continuity after every harvest. Post-harvest intervention innovations should be supported by a monitoring and evaluation system, incorporating stakeholders' feedback to deal with emerging issues in the adoption of such innovation.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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