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Factors Influencing Sustainability of Small Scale Fish Farming Projects in Kenya: The Case of South Imenti Sub-County, Meru County

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Abstract: The study sought to examine the factors influencing sustainability of small scale fish farming projects. Specifically, it sought to determine how cost of inputs, provision of extension services, accessibility to market and use of technology influence sustainability of small scale fish farming projects. It was guided by Diffusion of Innovation Theory (DOI) and Theory of Production. Mixed Method Research Design, was used targeting small-scale fish farmers in South Imenti Sub-county, Meru County. To collect both qualitative and quantitative data a target of 200 individual, group and other projectswas adopted. Questionnaire, interview schedules and focus groups were used as data collecting instruments. Of 150 questionnaires distributed 109 were filled and returned. Descriptive statistics (Mean, standard deviation, frequencies, and percentages) and inferential statistics (correlation) were adopted to measure relationships and give meanings. The study established that small scale fish farming projects are greatly influenced by provision of extension services ($r = 0.521$) indicating that an improvement of the services to the farmers results to higher and better yields which in turn result to sustainability. Access to market ($r = 0.411$) also influenced sustainability, this indicates accessing broader markets would consequently make fish farming sustainable. Use of technology ($r = 0.301$), proved to have an influence on sustainability implying that adoption and use of technology significantly influences the production positively hence making the projects sustainable. Lastly, cost of inputs ($r = 0.013$), the low value can be explained as the variable having dual impact on the respondents, while to some farmers high cost means less production there were others that high cost meant good quality hence high production.

Keywords: Cost of Inputs, Market Access, Provision of Extension Services, Use of Technology and Sustainabilityof Small Scale Fish Farming Projects.

I. INTRODUCTION

The global aquaculture growth rate was 6.9 percent per annum between 1970 and 2006[1] this declined with 1.1% between 2004 and 2008 due to increased catches. As at 2012[2], the global aquaculture production was at 11.6 million tones. This has seen aquaculture become the fastest growing food producing sectors in the world (FAO, 2012). According to HLPE, (2014)aquaculture has led to an increase in availability of fish and significantly contributes to the consumption of fish products worldwide.

In sub-Saharan Africa Small scale fish farming is rather a recent activity (FAO, 2004). However aquaculture in Africa continues to increasingly grow with millions of poor people relying heavily on fishing and farming to earn their livelihood and feed their families. Africa relies heavily on fish as an important source of animal protein (FAO, 2004). According to Eyster, (2014), the East Africa community as a whole has a potential of becoming one of Africa's leading economic power if integration is successful and handled properly. Aquaculture in East Africa counties is still a fairly new industry and with the current growth can barely meet the increasing demand for fish and fish products. The European Union through different development partners; Food and Agriculture Organization Indian Ocean Commission-Smart-fish (IOC-Smart Fish), African Union-Inter Africa Bureau Animal Resource(AUIBAR), Lake Victoria Fisheries Organization(LVFO) among others have made tremendous strides in the promotion of fisheries and aquaculture development in the East Africa countries.

The fisheries and aquaculture sector contributes about 0.6 per cent of GDP while aquaculture contributes 2.5 per cent of fishery output while it has a potential to contribute close to 50 per cent to Kenya fishery output (Kagiri, 2016). It plays a key role in the economic and social development of the country where it supports 500,00 directly and over 2 million people indirectly (KMFRI, 2017). In 2005, Kenya annual fish production was estimated at 160,000 Metric tons valued at 13 billion in 2011 this has a potential to double to an

[1] FAO 2009*a* .The state of world fisheries and aquaculture 2008
[2]FAO 2014.The state of world fisheries and aquaculture 2014

estimate of 26 million in 2015[3].According to KMFRI, 2017 Kenya's annual production has reduced to about 128,000 Metric tons valued at about Kshs 21 million at the farm gate price and another Kshs .1 billion in foreign currency earnings. This is derived from fresh water (81%), aquaculture (12%) and marine waters (7%). The drop in production especially in aquaculture was brought about by devolution of the agriculture sector to the counties, which has seen some counties not support aquaculture.

Fish farming is mainly done by small scale fish farmers who do subsistence farming under semi intensive type farming. This type of farmers are scattered all over the country making it hard to reach them. In 2009 the government of Kenya through the then Ministry of Fisheries Development implemented the Fish Farming Economic Stimulus Programme (ESP) whose main aim was to promote fish farming in the country. Through the programme, 200 earthen ponds were constructed where some of the beneficiaries included institutions, primary and secondary schools and small-scale farmers from 140 constituencies. Meru county and more particularly South Imenti Sub-county was among the beneficiaries of this programme. In 2014, Meru County had a total of 3,250 pond that were both ESP and non ESP occupying an average pond area of 926,250 M2, the total production that year was 2,037,750 kgs valued at 610.9 Million; South Imenti, Sub-County had 418 ponds occupying an average pond area of 12,400M2, the total production that year was 275,880kgs valued at Kshs86.4 Million (SDF,2014).

Despite the government initiatives to promote fish production, with the aim of creating job opportunities for young people, generate income and promote food security, the sustainability of small scale fish farming projects is still very low.

II. LITERATURE REVIEW

2.1 Sustainability of small scale fish farming projects

Sustainability is without doubt one of the most important challenges in today's time and immediate future. This is because most donors funded projects die as soon as the donor pulls out. According to WCED, (1987), sustainability as a concept of development is one that meets the need of the present without compromising on the future generation to meet their needs. Sustainability is very crucial and must be addressed as a requirement in any projects during its planning and design stages (Reza, 2012). Sustainability involves balancing or harmonizing social, environmental, and economic interests considering the full life cycle of any project. Economic sustainability has been defined as effectively and efficiently using available resources to ensure that the business continues return profit over several years. According to Foy, (1990) there are many ways to look at economic sustainability nevertheless:

In his article "sustainable aquaculture" Aquasol, (2003) gives three main economical areas that fish farming can be of help. The areas include growth, trade as well as standards of living. However his article does no elaborate as to how aquaculture has done this or would do this. Further, it also does not comment on whether fish farming has offered any benefits and who the benefits have gone to. Lastly, looking into the future the aricle does not comment on who this benefits will go to. According to Bernard, (2016) the final product quality and the individual task times are the major components of sustainability

2.2 Cost of inputs and sustainability of small scale fish farming

One of the biggest constraints to aquaculture development in Kenya has been lack of quality fish seed(Mary *et.al*, 2017). According to NARDTC G. a., (2014) seed production plays a key role in fish farming and its important for fish farmers to use good quality seed. Quality seed guarantees fastgrowth, high yields and good survial rate. Prior years, provision and distribution of fingerlings depended on government, this did not help the farmers as expected due to poor infrastructure and low production level. However the governemnet initiated two natioanl fish selective breeding programs for Nile tilapia and African Catfish at the National Aquaculture Research Development and Training Center together with Kenya Marine and Fishereies Research Institute in Sagana in collaboratiuon with other development partners, to develop national breeding nuclei with multiplication centers and hatcheries to distribute quality broodstock to hatcheries (NARDTC, 2013).

The KMFRI, (2017) have tried to increase fish production in fish farming by promoting fish seed production throughgenetic improvement and hormonal manipulation to produce appropriate fish seed/fingerling (monosex) that is resiliance to the kenya climatic conditions. Production of monosex tilapia fingerlings should enure that a minimum of 95 per cent are male (NARDTC G. a., 2014). Despite all efforts to promote production of quality fingerlings some farmers still feel that the cost of monosex fish seed is still very high thers lack that knowledge of where to get this quality fingerlings and end up buying mixed sex that does not give them maximum output.

[3] ASDS 2010-2020

This has led some farmers to using supplements using locally available raw materials for example Ochonga cassava leaves, sun flower, and white bran among others to feed their fish. These has further lead to farmers developing feeding strategies such as spreading feed at fixed points at same time daily, bag and restrict feeding techniques, break feeding schedules and promote natural pond productivity(Jonathan et al, 2014). The governemnt through the ESP programme promoted cottage industry through provision of fish feed pelleting machines, this pelleting machine produced bad quality pellets (sinking pellets). In 2015 the State Department of Fisheries through the Fish Quality Assurance Department developed a Manual of Standards Operating Procedures and the Residue Monitoring Plan to help ensure standards within the aquaculture sector. The lack of feed testing facility ie proximate analysis, Feed Conversion Ratio in kenya is still a major problem in trying to ensure production of quality fish feed.

2.3 Provision of Extension services and sustainability of small scale fish farming

Providing extension services to rural communities to improve their fish farming skills and capacity to increase their farming efficiency is very important in any project. by providing this services to the farmers it provides them with information on production, value addition, access to finance, marketing etc. Therefore provision of extension services play an important role in the development of aquaculture (Christian, 2016). *According FAO reports aquaculture extension services have played an important role in the development of aquaculture nevertheless more is expected in the future. At grass root level efficient extension services are required to promote the existing farmers and potential farmers for effective promotion of equitable and sustainable development of aquaculture sector. In Kenya fish farming was popularized in the 1960s by the government through targeted "Eat More Fish" campaigns to promote consumption especially in the eastern and central parts of the country*(Charles, 2007). Similary, to promote fish production and consumption in the country the governmnet initiated an ESP programme in 2009 (GOK, 2009). A report by KEPSA, (2013), indicates that in Kenya the effectiveness of extension services has declined over the last two decades due to a sharp reduction in operational budgets and human resource in the sector ministries. According to (FAO, 2004) one of the key problem in extension services is low level of support to field technician, those front line staff in direct contact with farmers.

Further Charlse and Manyala, (2004), in their study on Aquaculture extension services in Kenya shows extension services to be one of the major problems facing aquaculture sector development in the country mainly due to inadequate extension officers provided by the department of fisheries. A report by Sharma, (2004), indicates that government need to provide support services tailored to enable small scale farmers take up commercial farming through sustainable practices. In his research Bernard, (2016) also emphasised on the need to radically restructure extension services to make technology dissemination responsive to small farmers. Bethwell, (2007) stated that capacity building and skills training determine the success of agricultural developemnt to realize a projects objectives and for this to be fulluy achieved the guidline for life of thr project must be strongly implemented. Research conducted by Hope (2009) found that to be engage in a sustaiablle manner to develop posiitively and reduce poverty as well as meet all the MDGs, extension should be regareded as the key ehnancement of competency of farmers and local communities.

Based on research conducted by FAO, (2004) Aquaculture extension in sub-Saharan Africa, extension agents gain important training in both technology and participation. However, one of the lessons learnt from this study was that "quality extension" does not simply mean that technicians have adequate technical training. In Kenya, aquaculture systems are characterised by high cost of inputs, inadequate extension services and lack of markets all leading to low fish production in the country. Despite the National and County government being aware of the inadequate extension services in the counties, a lot of government and donor funded projects are being implemented before addressing the issue of indequate and trained extension workers.

An assessment done by Kato *et al* (2000), in Asia attempting to provide a sustainable flat-form for future growth in Cambodia's future growth, international development agencies have adopted an interlinked approach showing the critical role for growth on the local level, bottem up growth initivie predominantly in rural societies that remain largely organised around rural-urban weak link and surounding villages.

In conclusion, prior years aquaculture extension services have been seen to target commercial fish farmers. This has slowly changes and studies show that small scale fish farming can also contribute to poverty reduction provided the extension approaches are appropriate and flexible. Extension approaches that are currently being used in aquaculture and agriculture in general are considered inappropriate for majority of small scale fish farmers. The existing aqauculture extension services are under-resourced hence seen to suffer many of the commercial/large extension problems. To be able to have a more approriate extension approach that will develop small scale fish farming a participatory extension approach would be appropriate. Fish farmers and extension workers need to be equal partners in the development process.

2.4 Accessibility of market and sustainability of small scale fish farming

In Kenya, development of aquaculture has been occurring in recent years and marketing of aquaculture products has been an area of concern with many farmers desiring to attract international and regional markets(Mary. *et al*, 2017). KEPSA (2013) *report on 'The Kenya National Business Agenda II 2013-2018' states that while Kenya's agriculture is better developed than that of most countries in sub-Saharan Africa, the domestic market is poorly organized to take advantage of the regional market. Further, a report by* FAO (2016) *indicated that fish market in Kenya is classified according to target markets: local and international market, where local fish is largely sold fresh while international market involves high quality standards during handling, processing and storage. Reports by* AAK (2015), *indicated that supermarkets, hotels, schools, fish outlet center (establish through the Kenya productivity and agribusiness programme) are some of the main markets where small scale farmers sell their fish. On 30th July 2015 Kenya was listed among the countries to export farmed fish to the EU markets*EU(2015) *this opened up more market opportunities of fish and fisheries products to the European countries.*

According to Heinemann (2002), farmers in the rural areas in Africa, highlight access to market as one of the greatest challenge to improvement of their living standards. That notwithstanding, accessibility to fish markets in Kenya has been a teething problem due to low production. Daniel *et. al* (2015) in his fish farmers training manualadvised fish farmers to embrace cluster production and marketing approaches through cooperative societies to benefit from economies of scale. Daniel et al continue to state that fish production should be linked to market demand and fish farmers must ensure that they produce products demanded by the market. Several interventions have been made by development partners to promote competitiveness and access to market of farmed fish and fisheries products (Lucy *et. al*, 2015). kllick *et. at* (2000), Freeman and Silim (2001), IFAD (2003), Dorward *et.al*.(1998) in their studies on small scale agriculture marketing found that there are many challenges linked to access to market such as price risk and uncertinity, lack of organised small scale producers which increases the cost of putting together sparsly dispersed quantities of produce and also lack of meeting the required market standards. In Kenya for example, small scale fish farmers are geographically dispersed, roads are impassable , and farmers not able to meet the market demand. AAK (2014) confirm this by stating that in the previous years, marketing of fish for small scale fish farming was a major challenge due to farmers dispersed geographically and not well organised.

In South Africa, a study by Senyolo & Chaminuka (2009) showed that most emerging farmers emenate from groups of smallholder farmers who were previously excluded from mainstream economy however, accessibility and use of market by the group are two main factors that determine the development of this groups of farmers. According to IITA (2001), to solve these problems farmers have formed cooperatives and collective maketing associations to increase their burganing power in the market. AAK (2016) report say that fish in Kenya have formed cooperatives to help them market their fish. commercial fish farmers in Kenya have also been keen to forming mutually beneficial alliance with the small scale farmers to supply marketable products at an agreed price (AAK 2016).

According to Pinstrup-Anderson and Shimolwawa (2006), lack of good infrastructure leads to poor domestic markets with little or no room for spacial or temporal integration, low prices and weak international competitiveness. In Vietnam, poor road condition, high transport cost and market distance were identified as factors that hinder improved market access for aquaculture farmers which has also contributed to failing input market, Van & Tran (2016).

2.5 Use of new technology and sustainability of small scale fish farming

Technologies are increasingly being developed in a global market, for farm level application with an impact on the sustainability beyond the farm. Adoption and use of technology for sustainable fish farming systems is a multi-disciplinary approach taking into account a wide range of objective geared towards sustainable aquaculture.

According to FAO, (2017) over the last five years the system and technology used in aquaculture has developed rapidly. Similary, research by (El-Gayar, 1997) showed that recent advances in information technology have had profound impact on all walks of life and aquaculture is noexception. He continues to state that the growing importance of aquaculture as an alternative source for food protein has further emphasised the need to adapt and develop advanced IT for the better management of aquaculture facilities as well as the regional planning for aquaculture development. According to Wetengere, (2009) improving farm production through intergrated modern technologies into the existing farming systems is essential for the enhancement of household food and income security. His study recommended that technology developers should strive to improve the profitability of fish farming through the reduction of the rish of losing fish, shortening culture cycle to target market size fish, use of low cost inputs and/or intergrating fish farming with the existing farming systems and access to urban market.According to Olatunji and Ogunremi (2016) findings on awareness of fish farming technolgies by fuish farmers they found out that lack of awareness, lack of knowledge of effects of recommended technology or negative attitude to the innivation may be responsible for non-adoption among farmers. Being a technology era in Kenya reserchers such as Bowman *et al,* (2007) have found the need to serch for moer knowlwdge on the use and uptake of new technologies through extension to ensure sustainabilty of small scale fish farming projects

A research by Jacobi, (2013) indicates that one of the reasons for slow aquaculture development in Kenya has been; use of traditional fish and water husbandry, political, social and economic constains that restrict investment and delay expansion and lack of information on fish farming technology (Fisheries Department, 2012). In his study Henri *et al,* (2011) contend that adoption of fish farming technology is more likely to be adopted by the yonger farmers. However, SANISSA (2011) case study shows that it is difficult for some countries to obtain knowledge on pond designand construction, hatchery equipments and other farm inputs such as aerators, cages and hatching incubators.

In regards to the use of technology Rajan *e.t al,* (2013) research found out that feed management, selection and management of seed are some of the important technological components in fish farming. In his study Onzere, (2013) found that comminities still used traditional methods of fish farming, harvesting and preservation. In her research Kagiri, (2016) stated that lack of technology has lead to reduced output as well losses since the fish harvested cannot be stotred for long period that would enable fish farmers market their produce at a later date or even transport to a different location for sale. Wetenegere, (2010) states that fish farming has very high potental which can be fully utilized if only technology was adopted. According to Singas and Manus,(2014) farmers adopt fish farming technologies if they are assured that fish farming is a profitable venture. In his study Wetenegere, (2010) implies that importance of the recommended technology related to existing practices must be clearly demostrated to farmers. To ensure that the small scale farmers get the desired benefit, low cost technologies appropriate to the farmers needs to be extended widely. Contant information on new innovations made by research institutions like KMFRI can also help in drawing benefits from the innovations.

In conclusion technology adoption and use is quite broad and is affected by development, dissemination and application of the technologies at farm level especially farm capital and othe inputs. Its also affacted by extension, advise and information which form the basic of farmer knowledge as well as techniologies and practices in the overall agri-food sector that have an impact at the farm level. Fish farmers have always looked at new aquaculture technology as a way of reducing cost of production a clear indication that demand driven adoption and use of technology. Fish farmers invest in sustainable technology and farm practise if they expect the investment to be propfitable, have the right eductaion, information and motivation.

2.6 Theoretical Framework

2.6.1 Theory of production

According to a study byDouglas and Cobb(1928)the theory of production attempts to explain the effect of cost of inputs on sustainability of small-scale fish farming projects. Theory of production answers the question "how to produce" which further discusses the supply side of the product prices which depends on cost of production. Cost of production depends on the physical relationships between inputs and outputs as well as prices of inputs. This implies that the amount of production in fish farming projects depends on the cost of input(Kagiri, 2016). Some of these inputs include the invested capital to a fish farming project and the day-to-day running cost of the project meaning that the lower the cost of inputs, the lower the cost of production hence high level of production. This therefore, means that fish farming projects are making profits and hence sustainable in the long run. Hence, the cost of inputs is vital in the sustainability of fish farming projects. This theory therefore is important to this study since it highlights the influence of cost inputs in the sustainability of fish business enterprise.

2.6.2 Diffusion of innovation (DOI) Theory

Adoption of new technologies process studied for the past few decades with Rogers book Diffusion of Innovation being the most popular. This theory is appropriate for the study for investigating the adoption of innovation in fish farming. An innovation is any idea, practice or any object seenas new Rogers, (1995)by farmers while diffusion is the stages or processes of communicating these innovations using different channels over a certain period of time (Rogers, 1995). DOI looks at the how, why and at what rate new ideas and technology spread through cultures(Oliveria and Martins, 2011). According to Rogers, *(1995)* DOI theory stresses on importance of communication and stakeholder networking within the adoption process. Rogers distinguished adopters of innovation in five categories namely; innovator; the technology enthusiasts; early adopter; the visionaries , role models of the technology; early majority; the pragmatists, opinion leaders; late majority; the conservatives who were technology shy and required bullet proof solutions and laggards; the skeptics always maintain their status quo. This theory is a good example of how fish farmers adopt technology. Some farmers have managed to increase the level of adoption in fish farming by changing perception from subsistence to commercial and sustainable farming practicesRoseline, (2007) by incorpotating simple improved fish production technologies. While other have collapsed and droped out of fish farming.

This theory proposed five stages of adoption process: awareness stage; where the farmers is exposed to innovation/ new technology but does not have adequate information; interest stage; the farmers gains interests in the new idea and look for more information; decision / evaluation stage; the farmer decides to either try or not to try the idea; trial stage; where the farmer implements the new idea on trial bases and adoption stage; on this stage the farmer decides to fully utilize the innovation/ technology (Spring 2011). DOI theory is important for small scale fish farmers as it benefits the targets of change by ensuring involvement of all stakeholders with strong strategies for implementing innovative change.

2.7 Conceptual Framework

Conceptual framework in this study considered a way of structuring ideas together with the aim of achieving the research objectives. (Shield and Rangarjan ,2013). It shows how the independent variables are linked with the dependent variable (Antony *et al*. 2013). In this study, the conceptual frameowirk shows how the hypothesized factors such as cost of inputs, provision of extension services, accessibility of market and use of technology influence sustainability of small scale fish farming projects. Figure 2.7.1 shows an illustration of the conceptual framework for the study.

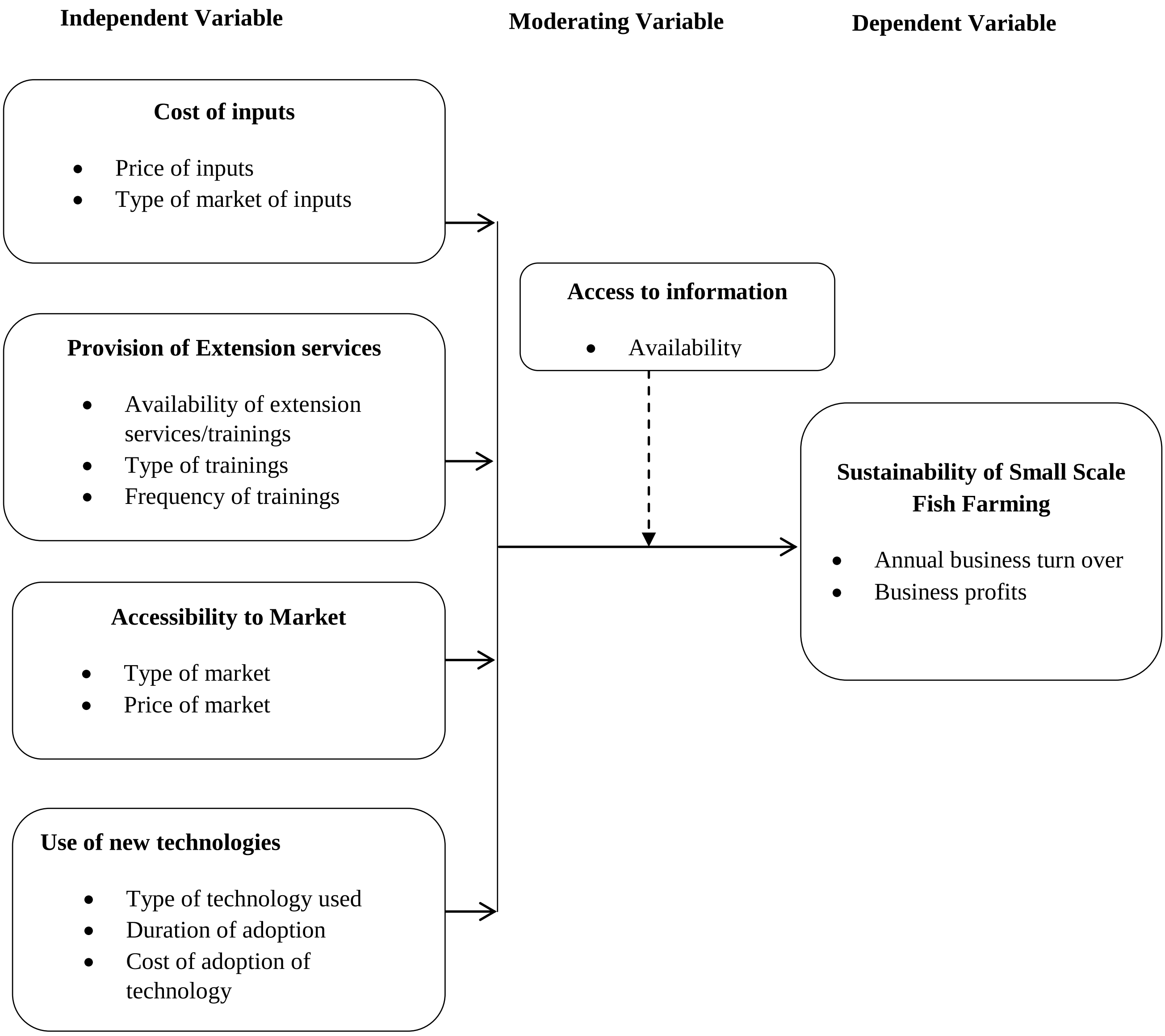

Figure 2.71 CONCEPTUAL FRAMEWORK

III. METHODOLOGY

The research adopted mixed method design, which gathers both qualitative and quantitative data, analyses both separately, then an intepretation was done on both to check whether they support or contradict one another (Creswell and Clark, 2011). To use the identifed research design, parallel questions were created for qualitative and quantitative aspects of the study.

Table 3.1 Target Population

Target population	Frequency
Individual projects	74
Group Projects	26
Other projects	100
Total	**200**

Yamane formula (1967) was used to compute the sample size for the study.

$n = \frac{N}{1+N(e^2)} = \frac{200}{1+200(e^2)} = \ldots = \frac{N}{1+N(e^2)} = \frac{200}{1+200(e^2)} = 133.33$

$n = \frac{N}{1+N(e^2)} = \frac{200}{1+200(e^2)} = \ldots$Where n is the sample size N is accessible population and e is the margin of error

For this research the sample was 134 plus 10% of 134 to cater for sampling errors, which yields a sample of 148 fish farmers for the study.

The researcher used list of projects provided by the Ministry of Agriculture, Livestock and Fisheries, Fisheries department South Imenti, Meru County, Aquacultural Association of Kenya and Meru Fish Farmers Cooperative. The researcher used both quantitative (questionnaire) and qualitative (interview schedule/focus group discussions and document analysis) to collect research data.

IV. DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Response Rate

Of the 150 questionnaires distributed to the small-scale fish farmers 109 questionnaires were returned giving a response rate of 72.67%. This rate conforms to Mugenda and Mugenda (1999) assertion that a response rate of over 50% is adequate for analysis and reporting.

4.2 Results of the Pilot Study

A pilot test was conducted in Kiambu County, Thika, Sub County where a total of 10 participants were randomly selected from the study area to participate in the pilot phase. The selection criteria was based on convenience, but care was taken to ensure participants represented various dimensions important to the study i.e. gender, fish farming experience and geographical location. The questionnaires were then adjusted based on the comments of the respondents to vividly capture the required objectives. The 10 respondents in the pilot study represented 9% of the target population, which agrees with the Mugenda and Mugenda (2003) suggestion of between 1% and 10% of the population

4.3 Demographic characteristics of the respondents

In section A of the questionnaire respondents were asked to respond to questions seeking to know their age and gender. This was to enable the researcher to compile the target populations' profile.

4.3.1 Gender of respondents

A total of 109 respondents completed their questionnaires, all of them indicating their gender. Of the 109 respondents, 71 (65.1%) were male and 38 (34.9%) female, as shown in Table 4.1.

Table 4.1: Gender of respondents

Gender	Frequency	Percent (%)
Male	71	65.1
Female	38	34.9
Total	**109**	**100**

This implied that the fish farming environment, particularly the small-scale fish farming projects are male dominated.

4.3.2 Age of respondents

Sustainability of fish farming may vary with the age of respondents. To avoid biasness, the study looked at the composition of the respondents in terms of age to better understand their familiarity with factors influencing the sustainability of small scale fish farming. Table 4.2 shows the results of the findings.

Table 4.2: Age distribution of respondents

Age	Frequency	Percent (%)
18 – 25	3	2.8
26 – 35	12	11
36 – 45	24	22
46 – 55	29	26.6
56 and above	41	37.6
Total	**109**	**100**

Regarding the age bracket of the respondents 37.6% (41) were aged between 56 and over while only 2.8% (3) respondents were aged between 18 – 25 years. This denoted that most small-scale fish farmers in South Imenti Sub-county were elderly and that fish farming is not taken as a serious economic activity by the youth in the area.

4.3.3 Education level of respondents

The education level of a farmer may present a yardstick for measuring the sustainability of fish farming. The study therefore sought to establish the education level of the small-scale fish farmers in South Imenti. The findings are presented in Table 4.3.

Table 4.3: Education level of respondents

Education level	Frequency	Percent (%)
Primary School	29	26.6
High School	57	52.3
Diploma	3	2.8
Bachelors	10	9.2
Masters	1	0.9
Doctorate	3	2.8
Others	6	5.5
Total	**109**	**100**

From the study, 52.3% (57) of respondents had high school qualification, 26.6% (29) primary school qualification, while collectively the remaining qualifications accounted for 21.1%. This implied that majority of the of small-scale fish farmers in South Imenti sub-county had high school education therefore have some basic knowledge on fish farming.

4.4 Challenges facing small-scale fish farming projects.

The respondents were presented with the two assumed challenges that the researcher wished to know in generality without breaking them down into smaller components how they affected fish farming. The challenges were; cost of input and access to market. The respondents were needed to rank them on a scale of 1 to 5 provided such that 1 = Least challenge and 5 = Most challenge. The findings are presented on Table 4.4

Table 4.4: Challenges facing small scale fish farmers

Challenges	Mean	Std. Dev.
Cost of input	4.5	1.077
Provision of extension services	2.88	1.483
Access to market	4.2	1.318
Use of technology	3.76	1.490

According to the results shown in table 4.1, the respondents feel the cost of inputs in fish farming is the greatest challenge they face with a mean of 4.5, while access to market had a mean of 4.2. This implied that the most challenging effect was cost of input and access to market.

The study also involved interviews and focus groups discussion with the small-scale farmers in South Imenti sub-country where the researcher wanted to get an in-depth understanding of the challenges the farmers were facing. Majority of the respondents identified cost of inputs such as fish feed and fish fingerlings as the greatest challenge. Respondent 1 said that "cost of inputs especially the fish feed and marketing of my fish is my major problem". The respondents also raised other challenges that they felt were critical if fish farming is to become more sustainable. This included; access to market, lack of information and cultural believes. The study also found that majority of the farmers had a dependency mentality relaying heavily on what the government or the donor funded projects had to give, the findings show in generality that cost of input was a major setback in sustainability of small scale fish farming.

4.5 Cost of input and sustainability of small-scale fish farming projects

Cost of input was categorized into cost of fingerling and cost of fish feed. First, the researcher wanted to find out where the farmers bought their fish seed/fingerlings from. The source of fingerlings can influence the quality of the final product which will in turn influence its marketing; the findings are presented in Table 4.5.1

Table 4.5.1 Source for fingerlings

Source	Frequency	Percent (%)
Government hatchery	33	30.3
Private hatchery	64	58.7
Self-propagation	4	3.7
All the above	8	7.3
Total	**109**	**100**

The research established that 64 (58.7%) of the respondents get their fingerlings from private hatcheries, government hatcheries contribute 30.3% (33) of the fingerlings, 3.7% of the farmers do self-propagation while 7.3% get their fingerlings from either government hatcheries, private hatcheries or they do self-propagation. This implied that 89% of respondents bought their fingerlings either at government institutions of private hatcheries. These findings show that the major source of fish seeds for farmers in South Imenti is private hatcheries, hence a need for regulation of the hatcheries to have superior quality fingerlings.
Cost of fish seeds/fingerlings was also considered as an aspect of cost of input and the findings are presented in Table 4.5.2

Table 4.5.2: Cost of fingerlings

Cost per fingerling (Kshs.)	Frequency	Percent (%)
< 5	5	4.6
5 – 10	18	16.5
10 – 15	57	52.3
> 15	29	26.6
Total	**109**	**100**

Averagely, the cost of fish seed/fingerlings in South Imenti appears to be ranging between Kshs. 10 and Kshs. 15 as reported by 52.3% (57) respondents. 26.6% bought their fingerlings at more than Kshs. 15 per fingerling, 16.5% (18) respondents bought their fingerlings at Kshs. 5 – 10, while only 4.6% (5) bought their seeds at less than Kshs. 5 per fingerling. The findings show that the price of fingerlings is more than Kshs. 10.
Next the researcher sought to know the cost at which the fish farmers bought the feeds per kilo since this is a key component of the cost of input. The findings are presented on Table 4.4.3.

Table 4.5.3: Cost of fish feed per kilo

Cost per kilo	Frequency	Percent (%)
Below 100	28	25.5
100 – 200	52	48.1
200 – 300	19	17.0
Above 300	10	9.4
Total	**109**	**100**

Majority of the respondents (48.1%) buy their fish feeds per kilo at between Kshs. 100 and Kshs. 200, while few 9.4% buy the feeds at more than Kshs.300 per kilo. The findings show that the cost of feeds per kilo in South Imenti is less than Kshs. 200, which is affordable.

From the interview and focus groups majority of the respondents felt the cost of inputs which included the cost of fish feed and cost of fingerlings was the greatest problem. Respondent number 3 stated that "the availability, quality and high cost of fish feed is a big challenge in these areas, I have resulted to formulating my own feed which costs me less than Kshs 100 to make as compared to buying from local manufacturer". The researcher also noted that high cost and availability of liner as a fish farming input was also a challenge to some farmers.

4.6 Extension services and Sustainability

Extension services are an important aspect of any form of farming. This research investigated the frequency, types, and satisfaction with the extension services among fish farmers in South Imenti, Meru County. To begin with, the researcher sought to find out whether the respondents had received any extension services, the findings are as presented in Table 4.6.1.

Table 4.6.1: Whether the respondents received extension services

Response	Frequency	Percent (%)
Yes	70	64.5
No	39	35.5
Total	**107**	**100**

About frequency of extension services, it was found that 32.1% (35) respondents received the services monthly, 19.3% (21) yearly, 7.3% (8) after every three (3) months and 5.5% (6) after every six (6) months. Two respondents did not fill this part hence the total respondents of 107.

There are several extension services that are offered to fish farmers, the respondents were provided with options to choose the type of extension service they have received. The findings are presented in Table 4.10.

Table 4.6.2: Type of extension service

Type of extension service	Frequency	Percent (%)
Pond management	36	43.9
Feed management	22	26.8
Record keeping	9	11.0
Marketing and value addition	15	18.3
Total	**82**	**100**

Most of the respondents 43.9% (36) as shown in table 4.10, reported to have received services on pond management training, this indicates that more emphasis by the extension officers was on how to manage the ponds. The least effort seems to have been put on record keeping at only 11% (9). The total number of respondents reduced from the initial 109 to 82, since the response to this question was reliant on whether the respondent had received extension services or not. The 82 are the ones who could have received extension services and therefore were capable of responding to this question. These findings indicate that most of the emphasis by the extension service provides is on pond and feed management. It would be important if the officers would train the farmers on all extension aspects available.

Based on the findings from the interviews and focus groups discussions many respondents said they had not received formal trainings from the fisheries officers however, they consult the officers from time to time when need arises or/and when they are faced with a challenge that needs technical expertise. Majority of the respondents claimed to consult mostly on pond management, feeding schedules and management, and fish marketing. For example, respondent 9 said "I recently had a problem with my fish pond the algae in the pond was too green and every time I fed the fish the food was left floating for days". Respondent 13 has this to say" I was used to seeing my fish play all the time then one day as I was feeding them I realized they were not as jovial and usual and this got me worried but when I called the extension officer in my area he was able to help and now my fish a playing". This two are isolated cases of how the farmers in the area receive extension services making it a least challenging factor since they can get extension as need arise.

Satisfaction with extension services was also considered and the research found out that 61.8% of the respondents were satisfied while 38.2% were not satisfied with the extension services they were being offered. Lastly, the researcher sought to find out whether the respondents thought provision of extension services would improve their yields. The findings are presented in Table 4.11.

Table 4.4.3: Extension services and production

Response	Frequency	Percent (%)
Yes	96	89.7
No	13	10.3
Total	**109**	**100**

4.7 Accessibility to Market

For any business to be successful, the product should have access to market. In this section, the researcher sought to find out where the farmers sell their fish and the price at which they sold the fish.

4.7.1: Fish market

Farmers were asked to indicate where they sold their fish and the findings are presented in Table 4.7.1

Table 4.7.1: Fish market

Fish market	Frequency	Percent (%)
Farm gate	62	57.9
Restaurants	7	5.6
Fish processing plants	19	17.8
Supermarket	5	3.7
Others	16	15.0
Total	**107**	**100**

Majority of the farmers (57.9%) sell their fish to farm gate after harvesting, 17.8% take the fish to fish processing plants for sale, and 15.0% have alternative markets which they did not specify. Those who take their fish to restaurants were 5.6% while only 3.7% take their fish to supermarkets. Two (2) respondents did not indicate where they sell their fish. From the responses, it is observed that the major market for the farmers fish in South Imenti, Meru County is farm gate.

4.8 Price of fish

The respondents were required to indicate the price at which they sold their fish. The findings are on Table 4.8.1.

Table 4.8.1: Price of fish

Price of fish (Kshs.)	Frequency	Percent (%)
Below 100	23	21.5
100 – 200	36	32.7
200 – 300	28	25.2
Above 300	22	20.6
Total	**109**	**100**

From the above table 4.13 it is clear that majority of the farmers 54.2% (58) sell their fish from Kshs 200 and below with 48.8% (48) respondents selling their fish above Kshs 200. This shows that the price at which farmers sell their fish in South Imenti ranges from Kshs. 100 to Kshs. 300.

From the interviews and focus groups discussions majority of the respondents felt that access to market was wanting. Most farmers said they sold their fish from their farms which fetched a low price; other said that they had joined Kanyakini fish farmers' cooperative society that helped them market their fish. The cooperative is a membership society and farmers have to pay a fee which also gives them an opportunity to buy shares that gets dividends at the end of the year. "I first joined the cooperative in August 2016 after I was referred by a friend, I was a startup farmer at the time and I didn't know where to sell my fish. Kanyakini fish factory told me they could buy catfish and tilapia at Kshs 350 and Kshs 300 from 300grams and to me this was better than the farm gate price my friend was getting" said Respondent number 4.

These findings show that price at which fish is sold could be dependent on where the farmers sell their fish, this is due to the almost equal distribution of respondents among the different class prices presented to them.

4.9. Use of new technology

4.9.1 Type of farming

The respondents were needed to indicate the type of farming they use. The findings are presented on Table 4.14.

Table 49.1: Type of farming

Type	Frequency	Percent (%)
Intensive	10	9.3
Semi-Intensive	77	71.3
Extensive	22	19.4
Total	**109**	**100**

Regarding the type of farming employed by the small-scale fish farmers in South Imenti, Meru County, 71% indicate that they used semi-intensive farming method, 20% who use extensive method, while only 9% of the respondents use intensive farming method. These findings indicate that most farmers used semi-intensive farming method in their fish farming.

4.10 Duration to adopt technology

The research also investigated how long it took the farmers to fully adopt the technology they are currently using. The results are presented in Table 4.10.1.

Table 4.10.1: Duration to adopt technology

Duration	Frequency	Percent (%)
1 month	24	24.7
3 months	26	26.8
6 months	19	19.6
1 year	15	15.5
Others	13	13.4
Total	**97**	**100**

Majority of the respondents 51.5 % (50) take duration of 1 to 3 months to adopt any technology. 19.6 % (19) take 6 months, 15.5% (15) take a year with 13.4% (13) taking more than a year to adopt technology. This denoted that farmers were willing to take up and use technology hence improving on their production.

4.11.1 Source of technology knowledge

This section looks at where the respondents got knowledge on the technology they are using. Respondents were asked to indicate where they learnt about the technology from and the findings are presented in Table 4.11.1.

Table 4.11.1: Source of technology knowledge

Source	Frequency	Percent (%)
Government fisheries officers	53	54.6
Donor programmes	5	5.2
Other farmers	31	32.0
Internet	8	8.2
Total	**97**	**100**

From table 4.16, the researcher found that majority of the respondents (54.6%) got knowledge on technology from government fisheries, 32% from other farmers, 8.2% from the internet while only 5.2% learnt about technology from the donor sponsored programmes.

From the interviews and focus groups discussions a big percentage of the respondents said they engaged in semi-intensive type of farming. Most respondents said they had installed liners in their earthen ponds while a smaller percentage (20%) said they had gone ahead and added raised wooden ponds to help improve their fish production. Majority said they took 1 month to put up a liner in their ponds while those with more advanced wooden raised ponds took up to 6 months with most of the respondents learning the new technologies from fisheries officers and other farmers. “I went to visit a farmer friend and I saw this technology I had to have, right now I have 24 small raised wooden ponds that I constructed in 7 months” says Respondent 10.
The results from the questionnaires and interviews both indicate that the predominant mode of fish farming in South Imenti is semi-intensive, which can be assumed to influence the sustainability of small scale fish farming.

4.12 Influence of technology

The research sought to get the opinion of the respondents on the influence of technology on fish farming, in particular improvement in quality and quantity of fish produced. The findings are presented on Table 4.12.1.

Table 4.12.1 : Influence of technology

Response	Frequency	Percent (%)
Yes	85	79.8
No	24	20.2
Total	**109**	**100**

79.8% (83) of the respondents said that technology influences fish farming by improving the quality and quantity of fish produces while 20.2% (21) said technology did not have any influence on their production.

From the interview and focus groups findings 80% of the respondents felt that technology did influence the fish farming. “When I started fish farming I started with grow out fish which at the time did not fetch good prices, I decided to venture in to fingerling production when I heard a few farmers in my area say they could not find good quality and affordable fingerlings. After a 6 months course at the National Aquaculture Training center in Sagana, I now have a small hatchery that I use to propagate catfish fingerlings and sell to farmers” said Respondent 5. This shows that most farmers believe that modern technology is helpful to their fish farming.

4.13.Fish farming sustainability

Sustainability of fish farming for this research was measured in terms of profit made after sale of fish and the annual turn-over. The farmers were asked through the questionnaire and interview to respond on these two aspects.

4.13.1 Annual business turn-over

Respondents were required to indicate their annual business turn-over. The findings are indicated on Table 4.13.1

Table 4.13.1: Annual turn-over

Annual turn-over (Kshs)	Frequency	Percent (%)
Less than 50,000	75	69.4
50,000 – 100,000	29	26.9
Above 100,000	5	3.7
Total	**109**	**100**

Majority of the respondents, 69.4% indicated they earn less than Kshs. 50,000 annually, 26.9% earned between Kshs. 50,000 and Kshs. 100,000, while only 3.7% had a turnover of above Kshs. 100,000. This implied that 69.4 % of the respondents had less than Ksh 50,000 annual turnover hence did not earn much from their business.

4.13.2 Business profits

Business profit was used as a measure of fish farming sustainability. Respondents were required to indicate whether they made profit or not, and the findings are indicated on Table 4.13.2.

Table 4.13.2: Fish farming profit

Amount of profit (Kshs)	Frequency	Percent (%)
Yes	53	48.6
No	56	51.4
Total	**109**	**100**

The proportion of the respondents who made profits and those who didn't make profits was almost equal as indicated in Table 4.19. This implied that even though 69.4% of the farmers earned less than Kshs 50,000 annually they still made profit from their business hence was sustainable.

For any business to become sustainable one has to be making some profits and fish farming is no different.

From the interviews and focus group discussions the researcher was curious to find out the approximately annual turnover of the respondents and whether they were making any profits from the fish farming enterprises. This however, proved to be a double-edged sword question for the respondents as some said they did not make any profit from their farming business while some said they were making a small profit meaning those who did and didn't make profit were almost equal. The researcher wanted to get a deeper understanding as to what the annual turnover of those making profits was as compared to those not making profit. Majority of the respondents making profits had an annual turnover of Kshs 50,000 and above while those not making profits had turnover of Kshs 50,000 and below.

Respondent number 50 gave an example of how since he started his fish farming business; he had not broken even from the business and is still operating on recurrent expenditure". Respondent number 50, attributed his lack of breaking even to high cost of inputs that take up almost 70% of total fish production cost. On the other hand, Respondent number 67 was keen to share his experiences that transformed his business. He started his business under losses and for a while he thought of leaving the fish farming and count his losses but after attending a seminar organized by Aquacultural Association of Kenya a farmers organization he learnt how to do fish farming as a business". He continued to say "after harvesting the fish I had at the time, I decided to add and upgrade my ponds, I also started buying mono-sex fingerlings and imported feed from Aller Aqua feed distributer in Meru and that's when I stated seeing the change. The fish that would take 10 months to a year to grow now took 6-8 months, since I had already added more ponds and I was stocking at different times of the month, I was guaranteed to sell my fish every month and this made the whole lot of difference for me". The findings show that the number of farmers who made profit from their farming was almost equal to those who did not make profits.

4.14 Inferential Statistics of sustainability of small scale fish farming projects

The strength of relationship between the variables in the study was quantified using the Karl Pearson's product moment correlation coefficient (r).

Table 4.14.1: Correlation of variables

	Cost of input	Provision of extension services	Access to market	Use of technology	Sustainability of fish farming
Cost of input	1				
Sig. (2-tailed)					
Provision of extension services	.059	1			
Sig. (2-tailed)	.768				
Access to market	.026	.102	1		
Sig. (2-tailed)	.514	.614			
Use of technology	.011	.121	.012	1	
Sig. (2-tailed)	.788	.811	.312		
Sustainability of fish farming	.013	.521	.411	.301	1
Sig. (2-tailed)	.144	.013	.025	.218	

* Correlation is significant at the 0.05 level (2-tailed)

Based on Table 4.18 on correlation of variables, it can be observed that the cost of input and sustainability of fish farming have a weak positive correlation, r = 0.013, with p = 0.144, provision of extension services and sustainability had a moderate positive correlation, r = 0.521, with p = 0.013, this implies that providing farmers with extension services would help improve their farming practice and hence make fish farming sustainable.

In regard to access to market and sustainable fish farming, the study found a correlation coefficient r = 0.411, with p = 0.025 which is a positive correlation, this means that if the fish farmers can access broader markets for their fish and fish products, then fish farming will become sustainable.

Lastly, the use of technology and sustainability of fish farming were also found to be positively correlated with a coefficient of r = 0.301, with p =0.218 meaning that if the fish farmers used technology to improve their annual fish production, then fish farming will become sustainable.

V. CONCLUSION

Despite the Government having injected funds through the ESP to boost fish farming in Kenya; both government and private sector constructing two fish mini processing plant in the area; farmers having access to information on how to manage their fish farming enterprises, sustainability of small scale fish farming projects is still influenced by a number of factors. These factors include; cost of inputs which need to be readily available, of good quality and require small scale farmers to have access to finance and access to market which need to be broadly available and the farmer able to produce enough to supply continually to meet the high demand for fish.

VI. RECOMMENDATION

The study recommends:

- Government should provide subsides on raw materials such as fish meal to make fish feed and lower the cost of fish production to promote competitiveness with other countries like China.
- Government should streamline and regulate agencies responsible for maintaining quality and affordable prices for fingerlings.
- Government should streamline, strengthen and harmonize the fish cooperatives in order to build capacity of producers, enhance competition and capital formation
- Government should promote local market by discourage cheap import from China.
- Farmer organizations should lobby the government to provide subsidies and lower taxes on farm inputs and other aquaculture equipment to help the farmer improve their production.
- Farmer organizations should promote fish consumption in communities such as South Imenti that culturally do not consume fish to change the communities' cultural perception hence wider fish marketing the country.

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