THE STATUS OF FISH FARMING DEVELOPMENT IN ARID AND SEMI-ARID COUNTIES OF KENYA: CASE STUDY OF MAKUENI COUNTY

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ABSTRACT

Between the year 2009 and 2013, the Kenyan government invested KES 22 billion in the aquaculture sector through the Economic Stimulus Programme (ESP). It was expected that more farmers all over the country would venture into the sector and therefore lead to an increase in aquaculture production. A study was therefore done in Makueni County one of the arid and semi arid countries in Kenya to investigate its fish farming status, the socio-economic aspects which affected its adoption and challenges facing the sector in that county. The study adopted a cross-sectional survey research design and a descriptive research paradigm. The results indicate a substantial variability in fish farming within the six sub-counties in Makueni county with some having relatively higher production than others. Majority of the fish ponds (92.5%) were funded by the government under the ESP however the project did not perform as expected. About 73% of the ESP funded fish ponds have so far been completely abandoned, while 11.3% are partially abandoned, with only 15.3% being functional. The issue of gender balance affected the program's adoption as only 9.9% and 29.2% represented the youth and women respectively. Generally, 76.6% of farmers interviewed cited lack of pond liner as their greatest challenge facing fish farming activities. Other challenges mentioned include, lack of fingerlings (59.3%), lack of finance (57.2%), lack of fish feeds (54.7%) and inadequate water (43.9%). It was observed that these challenges are increasingly affecting the performance of fish farming with more farmers continuously abandoning their ponds.

Keywords: Fish farming, ESP, fish ponds, pond liner, status.

INTRODUCTION

Fish and fishery products are among the most traded food commodities worldwide. In developing countries, fish and fishery products are worth half the total value of traded commodities which accounts for the bulk of world exports [1]. The aquaculture's current average annual growth rate of 6.2% has outpaced the world population growth of 1.6 % with all-time high of 90.4 million tonnes of fish being produced in the year 2012 [2]. According to reference [2] report on the state of world fisheries and aquaculture, Africa recorded the fastest growth rate of 11.7% in the aquaculture sector. It contributed to USD 2,776 million to the continent's growth domestic product (GDP) and 10% employment opportunities to its population [2].

In Kenya, the aquaculture industry has had stagnant growth since its inception in 1920s. The aquaculture systems in Kenya are characterized by small-scale extensive and few semi-intensive earthen and lined ponds, dams, and tanks. Nile tilapia (*Oreochromis niloticus*) is the

predominantly cultured species accounting for 75% of production. African catfish (*Clarias gariepinus*) accounts for 21% and the remaining 4% comprises of Common carp (*Cyprinus carpio*), Rainbow trout (*Oncorhynchus mykiss*), Koi carp (*Cyprinus carpio*), Goldfish (*Carassius auratus*) and Labeo (*Labeo victorianus*). Between 2009 and 2013, through the ESP, the government invested KES 22 billion with prospects of increasing fish production and opening up more areas of the country to aquaculture farming. Through this programme, the aquaculture sector production increased to 12,000 MT/y in 2013, which represent 7% of national fish production as compared to the 1,000 MT/y produced in the year 2000 [3]. The fisheries sub-sector was identified in the economic pillar with the vision to deliver the envisaged national economic growth of 10% annually. The main objective was to facilitate alleviation of poverty by providing food security, job creation, and encouraging fish farming and capture fisheries in rural areas [4].

The ESP programme first phase in the 2009/2010 financial year saw selected 140 political constituencies benefit with funds for 200 fish ponds (measuring on average 300m^2), 15 kgs of fertilizer and 1000 fingerlings of monosex tilapia per fish pond [5]. It was expected that, on successful harvests each of these ponds was to produce on average 270 kg of fish/year [6]. During the ESP second phase (2011/2012 financial year), an additional 100 fish ponds were added to each of the first 140 constituencies and an additional 20 new constituencies benefited with 300 fish ponds each making a total of 48,000 ponds countrywide [7].

In Makueni county, the first phase of the ESP programme (2009/2010 financial year) was implemented through the then Machakos District fisheries department (Current, Makueni county fisheries department). During this time, only Makueni and Kaiti sub-counties benefited with 100 fish ponds each. During the 2011/2012 financial year, the funds intended for Makueni county were moved from Machakos district fisheries offices to the current Makueni county fisheries department. This created a new opportunity for the other 4 sub-counties (Kibwezi East, Kibwezi West, Mbooni and Kilome). Mbooni sub-county benefitted with 300 fish ponds, Kibwezi East and Kibwezi West sub-counties received 150 fish ponds each while Kilome, Kaiti and Makueni Sub-counties benefited with 100 fish ponds each. During the 2012/2013 financial year, five sub-counties (Kilome, Kaiti, Kibwezi West, Mbooni and Makueni) benefited with 5 fish ponds each. In total, the county benefited with 1225 fish ponds. The projects identified 23 public dams within the county and were stocked with 132,500 catfish (*Clarius gariepinus*) and tilapia (*Oreochromis niloticus*) fingerlings.

After the government's revenue of KES 22 billion being allocated to ESP programme countrywide, the contribution of aquaculture in fish production and the economy was therefore bound to increase enormously [7]. However, the project did not perform as expected and this scenario forms the basis of this study. Most farmers in Makueni County and Kenya as a whole slowly adopted the fish farming project. However, not all constructed fish ponds were stocked with the 1000 tilapia fingerlings. The responsibility of the potential farmers was to purchase and install the polythene pond liners. Some of them did not meet this condition by the time the ESP programme funding came to a close.

There are many cases whereby the farmers eventually abandoned their fish ponds even before the first harvest. Reference [7] and [8] found out that, most of the farmers who are still holding on to

the venture are yet to realize their returns due to various challenges they are faced with. That notwithstanding, very little had been done to establish the performance and challenges of the project as it went into the subsequent phases. It is against this backdrop that a study was conducted in order to identify the factors that contributed to the failures and non-sustainability of ESP programme in Makueni County. The study will assist the county government, farmers and development partners in making informed decisions on proper implementation and sustainability of the aquaculture sector in the county.

OBJECTIVES
A. *Main objective*
To evaluate the current status of fish farming development in Makueni County towards sustainable development.

B. *Specific objectives*
1. To assess the current status of the fish ponds constructed under the fish farming ESP programme.
2. To evaluate if the socio-economic aspects of the potential farmers affected the adoption and performance of ESP programme
3. To identify the major challenges facing fish farming in Makueni and advise the county government on mechanisms of improving the sector.
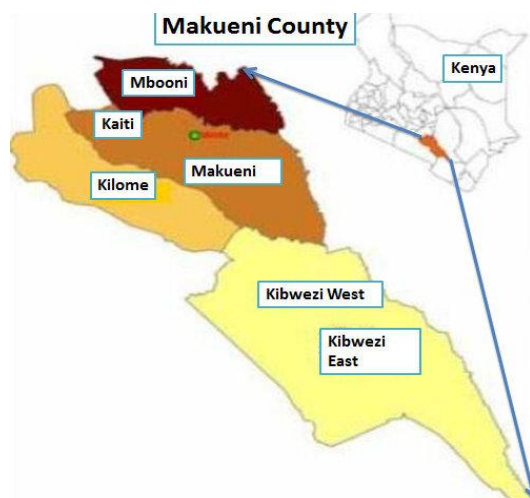
STUDY AREA

Fig. 1. Map of Makueni County

Makueni County is located between 1° 48' 0" S, 37° 37' 0" E, 1155 m above sea level, Eastern Kenya. The county extends to an approximated area of $8,034.7^2$ Km with a human population of about 900,000. The county borders Kajiado County to the west, Taita Taveta County to the South East, Kitui County to the East and Machakos County to the North**.** Administratively, Makueni County has six sub-counties namely, Mbooni, Kaiti, Kilome, Makueni, Kibwezi East, and Kibwezi West as shown in Fig. 1. The Makueni sub-county hosts the county administrative unit.

Makueni County is among the driest part of Kenya as it lies in the arid and semi-arid zones of the country. It receives an average annual rainfall of less than 361 mm. The rains vary during the long rains of April and November/December and short rains between February and June-September. River Athi, Kiboko and Kibwezi are the only perennial rivers in the county. River Kaiti, Muooni, Makindu, Kambu and Mtito Andei dry barely one month after the two rainy seasons.

A number of agricultural activities are carried out in the county including horticulture and livestock farming. These agricultural activities give the county a high potential for integration with fish farming. The county has temperature ranges of $21\text{-}29^0\text{C}$ which are optimal for farming of Nile Tilapia and African Catfish. Its proximity to other towns such as Machakos and cities such as Mombasa and Nairobi connected through the busy Nairobi-Mombasa highway provides market avenues for fish and fish products from the county.

METHODOLOGY

The study adopted a cross-sectional survey research design and a descriptive research paradigm which focuses on the individual fish farmers as the unit of analysis [9]. A list of fish farmers was obtained from the fishery's department offices of Makueni county. The research targeted a population of 1225 fish farmers with a total 1525 ponds. The target population was identified based on accessibility and willingness to participate in the survey. Interpretation and clarification was provided to the farmers who lacked the ability to write, read, and understand the set of questions and respond within the stipulated time as recommended by reference [10].

The study opted for personal interviews on each farmer against the simple sampling technique so as to get contacts for future collaborations, networks, linkages and gives each farmer an opportunity to dig deeper into the subject of the questionnaire (11).

The tool used to collect the data was a set of structured questionnaires to for the ease of understanding and in order to collect both quality and quantity data. The questionnaires were pre-tested by randomly sampling 2 fish farmers in each sub-county whom were not part of the target population. Finally the questionnaires were refined and polished and administered to the target population with the help of extension officers from the entire Ministry of Agriculture within Makueni county.

The data was coded and typed in MS Excel before it was analyzed using the Statistical software package, SPSS (Statistical package for social scientists). The computation of frequencies and percentages of each variable were done using the descriptive statistics. Finally the data was tabulated in tables and corresponding graphs were done using the MS Excel.

RESULTS AND DISCUSSION
A. *Farmers information*

TABLE 1: FARMERS INFORMATION (%)

		Weighted	Kaiti	Makueni	Mbooni	Kibwezi	Kilome
Number of Ponds		**1276**	310	215	350	309	127
Source of funding	Personal	**16.2**	7.6	3.9	20.1	29	17.2
	Government	**81.6**	92	95	76.1	66	81.7
	NGO	**1.5**	.4	.6	2.2	3.4	0
Ownership	Individual	**81.8**	86.	81	87.7	75	69.1
	Society	**1.1**	.9	.6	1.1	1.7	1.1
	Group	**9.6**	5.7	8.3	3.7	17	18.1
	School	**7.3**	6.1	10	7.1	5.1	11.7

A total 1031 farmers and 1276 fish ponds were accessed and assessed which accounted to 84.2% of the targeted population of 1225 fish farmers with a total of 1525 ponds. Table 1 shows that, 7.6% farmers interviewed funded their own ponds, 0.4% was funded by NGOs particularly the Kenya Redcross while the remaining 92.5% of the farmers were funded by the government under the ESP project. Majority of the farmers (80.6%) were funded with one pond while it was confirmed that, the 19.4% of the respondents who owned more than one pond, either had some ponds constructed before the ESP project or they constructed more ponds afterwards. Only five farmers in the entire county own more than 5 ponds which are all concentrated in the Kiboko swampy area within Kibwezi west sub-county.

B. Socio-economic status of the potential farmers

About 58% of the fish farmers interviewed were over 45 years of age. It was only in Kilome Sub-county where the majority (52.1%) of fish farmers were between 36-45 years as shown in Table 2 below.

TABLE 2: DEMOGRAPHIC INFORMATION (%)

		Weighted	Kaiti	Makueni	Mbooni	Kibwezi	Kilome
Age of Respondents	16-25	**.5**	0	.6	.4	.9	1.0
	26-35	**9.9**	5.7	6.2	7.1	16.2	19.8
	36-45	**30.9**	28.4	32.2	30.1	24.5	52.1
	over 45	**58.7**	65.9	61.0	62.5	58.5	27.1
sex	Male	**69.5**	77.0	76.7	71.9	58.1	62.5
	Female	**29.2**	23.0	23.3	27.8	40.5	33.3
Marital status	Single	**4.7**	4.8	2.3	1.5	7.9	10.4
	Married	**91.7**	94.3	95.4	95.2	84.7	85.4
	Divorced/ separated/ Widowed	**3.2**	.9	2.3	2.2	7.0	4.2

The minority age of farmers (0.5%) were between 16-25 age groups which even missed out in some places such as Kaiti Sub- county. The youth aged below 35 years represented only 9.9%. This is a clear indication that the youths were not fully involved in the ESP program. This could be explained by the fact that, first the traditional way of land ownership system in the community is mainly controlled by the elderly people. Secondly, the ESP program targeted those farmers with land. Thirdly is due to the high rate of the rural- urban migration of youths who may not have taken interest during the sensitization about the ESP programme.

Majority (69.5%) of the respondents Countywide, were males with only 29.2% representing the female. Kibwezi Sub-county had the highest representative of female farmers at 40.5% followed by Kilome Sub-county with 33.3%. The same reason of land ownership being controlled by men, there is the possibility that women were being sidelined during the sensitization. As expected, the married had the greatest representative of 91.7% of the fish farmer's population in the entire County. Kilome Sub-county had the highest singles and Divorced/separated/Widowed fish farmers at 10.4% and 4.2% respectively. It was observed that the males control the units of ownership and family income in most homesteads. Most of the labor in the fish ponds was however directed or done by females despite the male owning the pond(s).

TABLE 3: SOCIO-ECONOMIC ASPECT (%)

		Weighted	Kaiti	Makueni	Mbooni	Kibwezi	Kilome
Monthly Income	0-10000	**35.1**	47.1	19.7	40.5	33.9	22.9
	10001-20000	**30.6**	30.8	28.9	23.2	32.1	50.0
	20001-30000	**14.9**	9.3	21.4	13.5	18.1	12.5
	Over 30000	**19.2**	12.8	29.5	22.8	15.4	14.6
Main Source of income	Agriculture	**56.5**	56.6	55.5	67.7	54.7	35.8
	Business	**15.8**	14.5	10.4	10.5	16.0	41.1
	Employment	**26.2**	28.1	34.1	18.3	27.6	23.2
Fish Income	Yes	**5.5**	.6	0.1	0	5.2	
	No	**94.2**	98.9	0	0.1	94.8	
Reason for fish farming	income	78.9	80.8	80.1	76.1	84.5	67.7
	idle land	6.8	1.9	10.3	7.3	3.4	12.9
	benefit from ESP	10.0	15.4	.7	13.7	.9	7.5

The few cases where female owned the fish ponds were where their husbands had passed on or living in the cities or the women were single. This shows that much emphasis and empowerment is needed to ensure that there is involvement of the youths and the women in fish farming.

Table 3 shows that, 56.5% of those interviewed carried out agriculture as their main source of income, with only 5.5% of the farmers depending on fish farming as their main source of income. This means that, most beneficiaries already had other sources of income where they

spent most of their efforts. These findings indicate that much effort in terms of capital, inputs and labour are much allocated to other sectors other than fish farming. A further 79.9% of the representative population who responded showed that they started the venture to improve family income as a total of 65.7% of the respondents earned below KES. 20,000 per month. Another 15.4% started fish farming to benefit from the project funds and it is possible from the reaction of some farmers that they did it just to boost their status symbol.

C. Current State of fish Ponds

Fish farmers who had fish in their ponds and practiced most of the pond management practices such as feeding, changing water, fertilizing, fencing and/or harvesting were considered functional. Farmers with partially functional ponds, stocked their ponds, but very minimal if any, management practices are observed although they expected to make harvests out of it. Those who completely abandoned their ponds do not even stock their ponds. A large number of potential fish farmers have never stocked their ponds because of the inability to afford the pond liners which were being sold at an average of KES. 70000. This led them to either abandoning the project or purchasing cheap poor quality pond liners which got torn soon afterwards. Conmen, who took the advantage of the naivety of the "potential fish farmers", could pose as fisheries officer and sell poor quality pond liners, fingerlings and fish feeds. It was notable that some of the farmers who had abandoned the project had either filled the pond with soil or were growing crops in them. All farmers who bought the fake liners abandoned their ponds immediately the liners got torn. This was rampant in Kibwezi, Makueni and Mbooni Sub-counties. Following the above pond tagging, the study results shows that only 15.3% of fish farmers have their ponds operational, 11.3% of the ponds being partially abandoned and a massive 73% of
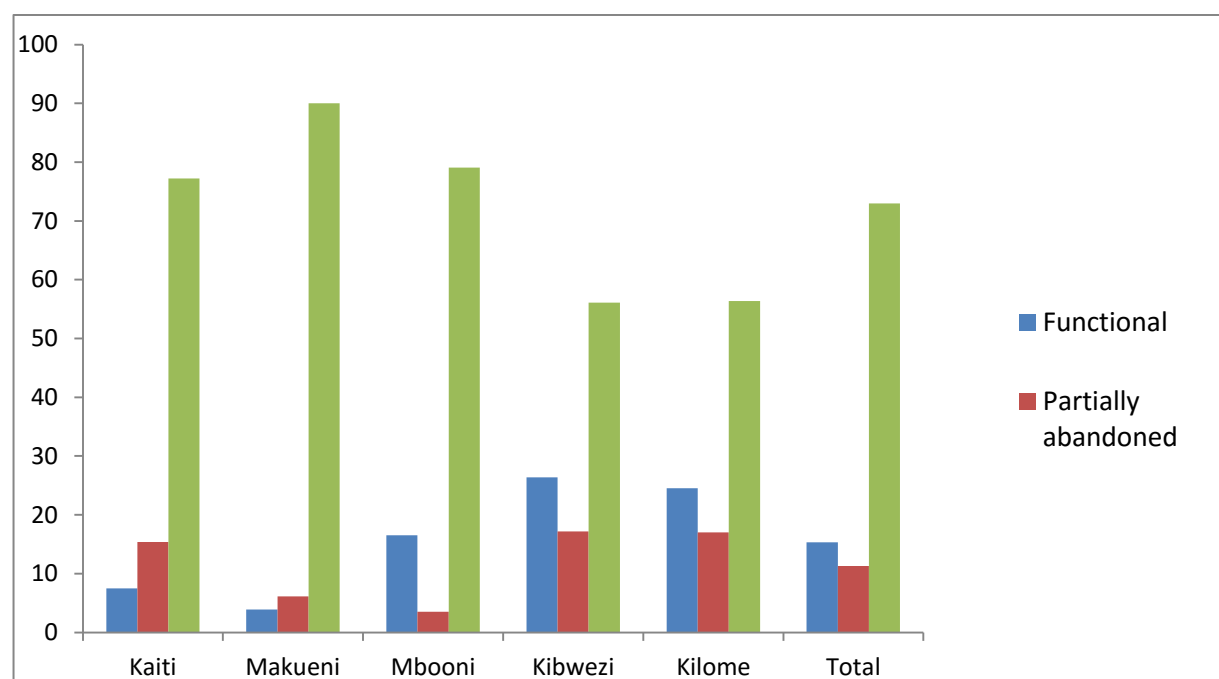

Figure 2: State of fish ponds (%)

the farmers having completely abandoned the project. Kibwezi Sub-county, has the highest number of functional ponds (26.5%) and partially abandoned ponds (17.2%). Most of these

functioning ponds are concentrated around the Kiboko swampy areas where water and pond liner did not pose a great challenge. The majority 56.1% fish farmers who had completely abandoned their ponds were within Kibwezi East Sub-county which is characterised by water scarcity among other challenges. Kilome Sub-county, 24.5% had the second highest number of functioning ponds and 17% partially abandoned ponds as most of the fish farming was done along the few permanent streams. Makueni Sub-county, 90% had the highest number of abandoned ponds (90%) followed by Mbooni Sub-county (79.1%) then Kaiti Sub-county which had 77.2% abandoned ponds and 15.4% being partially abandoned.

D. Weighted challenges
The study shows that each Sub-county is being faced by more or less the same type of challenges though in different magnitude related to their state of ponds. Fig. 3 below shows the magnitude of each challenge. The green color indicates the percentage of farmers who did not find the
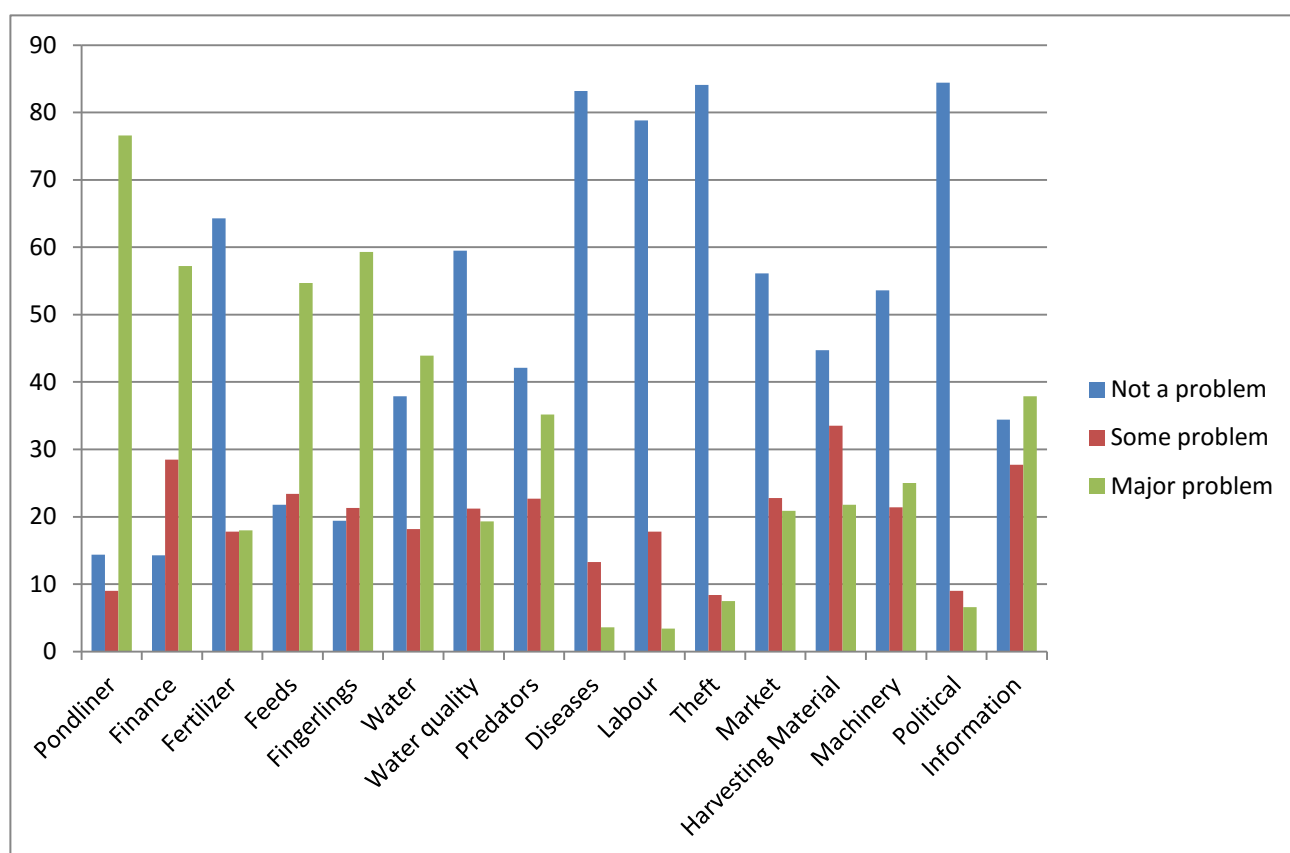

Fig.   3:   Challenges   (%).

Corresponding challenge as a problem and did not pose any alarm to fish farming. The red colored bars signified how the corresponding challenge had some problem which they can be tacked with minimum efforts. The green colored bar was a sign that a challenge was of major problem which if not checked can cause the abandonment of fish ponds.

1. Pond Liner

Generally, the 11.3% and the 73% of fish farmers who had partially and completely abandoned the project respectively picked pond liner as the main challenge facing fish farming in Makueni County. The ESP was funding the cost of pond digging, fingerlings supply, 15 Kgs of fish feed per each pond constructed and only limited number of pond liners which were mostly supplied to institutions. Therefore many farmers have not been able to
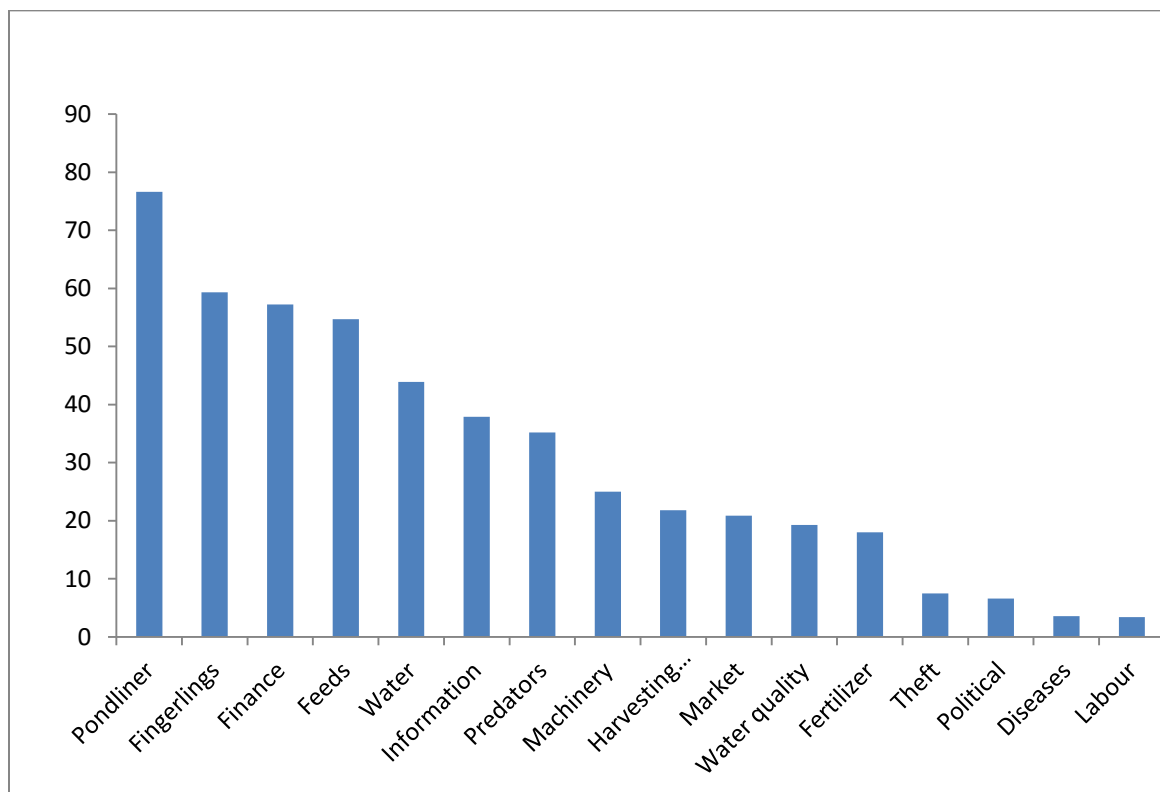

Fig. 4: Order of challenges (%)

purchase pond liners up-to-date. From the study it was revealed that it was not only impossible to acquire a pond liner but also get quality one. The same reason which led to some farmers being duped by brokers who sold them normal polythene papers which were not UV treated thus could not sustain single production cycle.

2. Lack of Fingerlings

Lack of fingerlings, was the second greatest challenge with 59.3% of farmers saying they not only lack reliable supply of fingerlings but also lack quality ones. Ever since the ESP project was initiated, there was the problem of fingerlings supply. First, this was because the project was a countrywide exercise and by that time very few fish hatcheries had the capacity to meet the huge fingerling demand. Secondly, majority of farmers could not access the mono sex male tilapia easily. When the government could not provide more fingerlings, farmers either abandoned the project or were forced to restock the previous harvested stunted fish. The few farmers who went past this challenge were faced with the problem of lack of quality fingerlings. They either procured mixed sex tilapia or wild tilapia which could not survive under captivity. Due to the

culture of community living within the county, Nile tilapia is the most favored fish species as it got more market preference and is favored by environmental conditions. Mixed sex tilapia, was the most farmed fish species within the County by majority (83.2%) of the farmers, while 61.1% of the farmers had a stocking density of $1/m^2$ instead of the recommended $3/m^2$ which explains the reason for low adoption of the project.

3. Lack of finance

Lack of finance was the third greatest challenge facing the County at 57.2%. Farmers who lacked finances were unable to acquire the inputs required for better management of the ponds. Majority only managed to acquire locally available cheap inputs such as pond liners, fingerlings and feeds. Fish farming in Makueni County is practiced on idle or parcels of land that are currently being used for other agricultural activities.

4. Lack of Feeds

Fish feed is one of the major components in fish farming. As expected, more than half of the fish farmers population sampled, had a major problem with fish feeds. About 54% of the farmers whose ponds are still functional cited lack of feed as one of the major limiting factors. Majority of the fish farmers (91%) use the commercial fishmeal with 42% of it being supplied by the government and an extra 34% being procured from nearby vendors. Interestingly majority of the fishmeal given to the fish was the one formulated for chicken and it is known to lack proper nutritional requirements for fish.

Almost half of the interviewed populations cited the government as their main source of feed with only 8.3% formulating their own feed using the locally available resources. Other farmers admitted feeding their fish using wastes from kitchen, garden and market. In extreme case, farmers used any other feed they thought would be good for their fish since manufactured feeds were either not readily available or was way expensive. Farmers who have partially abandoned the project, had their fish go for days without food with the lucky ones being fed once a day or when the feed was available.

5. Inadequate water

Makueni County being a semi-arid region, lack of water was expected to be the greatest challenge. On the contrary, this was not the case. This can be explained by the fact that, the 37.9% of farmers who said water was not a major problem are among the project beneficiaries who did not go past the pond liner challenge. Thus, they might not have known if water is/was a challenge. The 43.9% of the sampled population who had major problem had already abandoned the project. Consequently, the 18.2% of the farmers who had some problem with inadequate water have many of the partially functioning ponds. Majority of the functioning pond, the farmers are either along permanent rivers as shown by the 44.9% farmers who said their main source of water was pumped from rivers. Rainwater is generally the second main source with the exception of Mbooni Sub-county whereby 47.3% of the farmers harvest rain water for their fish farming. Borehole only supplies water to 9.1% of the fish farmers. There were few cases of wells (8.1%) and tap water (6.3%) being used as source of water for the ponds whereby the cost of

pumping is known to adding considerable impact to their costs of operation. Poor water quality was not found to be a major problem as only 19. 3% of the farmers considered it as major problem. From close consultation with these farmers, they cited oil pollution from pumping machines used in the river bank irrigation farms as their main challenges to water quality.

6. Inadequate training/Information

Majority of the sampled farmers, 64% cited lack of information or training as a major and some problem respectively. It is widely accepted that during the ESP projects was hurriedly initiated without proper sensitization of both the farmers and the supervisors. Extension officers were the main source of information to farmers. Majority of the farmers stated that they only received training and information during the early stages of project implementation in 2009. Since then they claim that they are rarely visited by extension officers. However, a great number of farmers with functional ponds particularly those within Kiboko area appreciated current County government's effort as they were not only provided with handy information and training but also was exposed to other successful farmers around the country. Despite the internet having all the necessary information which is easily accessible, only 0.4% of the farmers utilize it.

7. Predators

More than 35% of the respondents considered predators to be a major problem. Theft/sabotage contributed to 7.5% of the farmers in abandoning the project. King fisher and pelican were cited as the most common fish predators particularly in large water bodies and in areas with high concentration of fish ponds such as Kiboko. Toads and frogs were evidently seen in some ponds and some few cases of snakes and monitor lizard being reported mostly by farmers who had not properly fenced their ponds.

E. Improving fish farming

To evaluate the urgent needs which farmers wanted addressed promptly, all the farmers were requested to give their recommendation about the project and their future expectations/plans in fish farming. As much as they gave diverse opinions, credit provision, quality fingerlings, extension services and feed were reiterated by majority of the farmers who were still passionate about the project. Those farmers who had never procured the pond liner were very optimistic that, if by any chance it was provided, they could make the best out of fish farming. Most of the farmers with functional ponds sounded enthusiastic about fish farming and agreed that they would expand their farms to accommodate the fish demand. They noted that as much they didn't entirely consider fish farming as their main source of income, they felt culturing fish is good business due to the profits gained from it. A considerable number of farmers around Kiboko area have already gone ahead to expand their activities by constructing more ponds, others are even phasing out other non-profitable farm activities such as maize farming in order to give space for fish farming development. Those who had partially abandoned the project had mixed reactions some indicating that if given a chance they would reinvest in their farms with others feeling the challenges they faced are too vast to overcome. Majority of farmers who had completely abandoned fish farming were still passionate about the project indicating that if the new County Government was to provide them with basic limiting factors, they would go back to the project.

Disappointingly, some farmers were very categorical that, they needed nothing to do with fish farming. Some threatened to sue the government for causing them big losses which they incurred through procuring expensive liners which never supported one production cycle. They also lamented how they considered the abandoned pond as a lost arable land.

CONCLUSION

Fish farmers in Makueni County do not consider fish farming as their main economic activity since most of the ESP beneficiary farmers depended on other activities for income. This means that fish farming come last in their scale of preference when it comes to allocation of inputs, time and manpower. This affected the adopting and performance of fish farming because majority abandoned the project immediately they were faced by the first challenges. Other indirect challenges which led to abandonment of fish ponds were age, low level of education and relatively low income levels. The greatest challenges which directly caused the huge numbers of pond being abandoned were lack of pond liner, lack of finance and inadequate water. The study further found out that, farmers are being faced by the major challenge of lack of feeds and fingerlings which are essential for continued aquaculture production. The farmers also do not receive adequate extension and training services from the extension officers. The extension officers in return are not into capacity, lack adequate training and facilitation. The county not only lacks basic machinery for supporting fish farming such as sufficient fish harvesting materials and feed pelletizers but also a demonstration site. This is out of the fact that fish farmers need to be trained on various aspects of pond management practices to increase their output.

ACKNOWLEDGMENT

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