

## EFFECT OF FISH FARMING ON HOUSEHOLD FOOD SECURITY IN WESTERN KENYA

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## ABSTRACT

This study examined the impact of fish farming on household food security and livelihoods of fish farming and non-fish farming households in Siaya County. Fish farming involves raising fish commercially in tanks or enclosures, usually for food. Currently fish farming remains under developed in Western Kenya where pond productivity is low and not rising, despite the efforts of several players including the national government of Kenya. Further, capture fishing in Lake Victoria and rivers has been declining. These scenarios called for the need to examine the production systems and their current performances. The objective of the study was to examine effect of fish farming on household food security and livelihoods. A correlational research design was adopted for the study. Stratified random sampling was used to select fish farming and non-fish farming households. For nutritional assessment, lactating mothers and pre-school children were selected through stratified and systematic random sampling. Chi-Square revealed slight association between nutritional status and fish farming ( $\chi^2_{4,0.01} = 0.448$ ;  $p > 0.05$ ) though not significant. Analysis of variance found a higher dietary diversity score for fish farmers at 77.1% (CL: 95%) compared to 14.6% (CL: 95%) for non-fish- farmers on the high end Hoddinote Scale. From the measurement of the mid upper arm circumference (MUAC) of pre-school children, a correlation coefficient was determined to establish if there is a relationship between improved nutritional status and fish farming. Findings were that non-fish farmers experienced more food shortages than fish farmers. Children from fish farmers' households were well nourished as compared to those of non-fish farmers. This study will benefit farmers since they will adopt Best Management Practices in fish farming in order to improve their household food security and livelihoods through increased income. Increased fish farming will avail fish as food hence improved food and nutrition security to curb incidences of under-nutrition in pre-school children and lactating mothers.

**Key words:** Fish farming, Food security, Livelihoods, Household, Nutritional Assessment



## INTRODUCTION

Fish farming efforts have increased consumption of fish products dramatically and now average about 14 pounds/person/year in America [1, 2, 3, 4]. It is preferred because healthy farm-reared fish, guaranteed free of diseases, pesticides, and other harmful toxicants, are a more desirable substitute for wild fish from potentially polluted waters [1, 2]. As wild fishing stocks collapse through over-fishing, fish farming is growing rapidly [3]. In 1970, only 5% of the fish eaten came from farms, today over 40 % of the fish eaten is farmed. It is predicted that by 2048 all species of sea fish will have collapsed forcing us to rely almost exclusively on farmed fish [4].

Fish in the farms are reared in large numbers through various culture systems, the most prominent being; extensive, semi-intensive and intensive [5]. Warm water fish farming in ponds began in Kenya in the 1920s, initially using tilapia species and later including the common carp and the African catfish. In the 1960s, rural fish farming was popularized by the Kenya Government through the “Eat More Fish” campaign [6]. As a result of this effort, tilapia farming expanded rapidly, with the construction of many small ponds, especially in Kenya’s Central and Western Provinces [7]. However, the number of productive ponds declined in the 1970s, mainly because of lack of quality fingerlings and insufficient training for extension workers [8, 9, 10]. Today, following the renovation of several government fish rearing facilities, the establishment of research programs and intensive training programs for fisheries extension workers, there is renewed interest in fish farming in Kenya. Farmers in suitable areas across the country are again turning to fish farming as a way of producing high quality food, either for their families or for the market. To help alleviate poverty and provide food in the country, the government of Kenya launched the Economic Stimulus Program for fish farming in 2009 [11]. This project is contributing to the country’s economy through employment and enhancing food and nutrition security.

## MATERIALS AND METHODS

Data for this study was collected from among households of fish farmers and non-fish farmers in Siaya County of western Kenya, which is composed of six districts: Alego Usonga, Gem, Bondo, Ugunja, Ugenya and Rarieda. The county was purposively sampled because poverty is still a major challenge. Stratified random sampling was employed in selecting the respondents for the study. The households were drawn from each of the six districts within the county.

According to the 2009 census, Siaya County has a total population of 842,304 of which 398,652 are male, while 443,304 are female [6]. The county lies between latitude 0° 26’N to 0° 18’N and longitude 33° 58’ East and 34°33’West [9]. The county borders Busia County to the North and Kisumu County to the South-East (Figure 1).

Using Fisher’s formula lactating women and children under the age of five years were selected from every sampled household. The children below five years were chosen because their physiological and physical changes are more sensitive to changes in food



and nutrient intake and are, therefore, likely to reflect the nutritional status of the household [9].

Data were collected from household heads as well as the vulnerable members of households such as children under the age of five years and lactating mothers. This aimed at establishing if the fish farming or non-fish farming activity affected their household food security and livelihood. The key informants were purposively selected and they included the District Fisheries Officers, District Development Officers, Beach Management Chairmen (BMC), Church leaders, political leaders and administration leaders.



**Figure 1: Map showing Siaya County (Source: GoK Maps, 2012)**

A sample size of 384 respondents was adopted, with 192 households for fish farmers and 192 households for non-fish farmers spread in the six districts of Siaya County. Individual households were selected through stratified and systematic random sampling. A sample of 83 for children under five years old and 54 for lactating mothers were selected from the fish farming households; this sample was representative since it was well above the minimum calculated sample of 73 and 38 for the children under five years old and lactating mothers, respectively. A similar sample size was selected for the non-fish farming households and the rest of the respondents (110) were the key informants who were engaged in focus group discussions.

The study adopted a correlational research design to generate both qualitative and quantitative data. It involved comparing the food security situation of households of fish farmers and non-fish farmers [1]. This comparison was made in terms of availability of

food, fish as a supplement of household food supply, frequency of consumption of fish in the household, access to fish as food, utilization of fish within households, dietary diversity, as well as nutritional status of children less than 5 years of age and lactating mothers. Food diversity score was rated based on the following scale: 1-4= Low, 5-8 = Average and 9-12 = High on a 24 hours recall period. Various food types were categorized into 12 groups. Data on the children's nutritional status were summarized and rated on the following MUAC tape scale: Green= well nourished, Yellow = at risk of malnutrition and Red= severely malnourished [2].

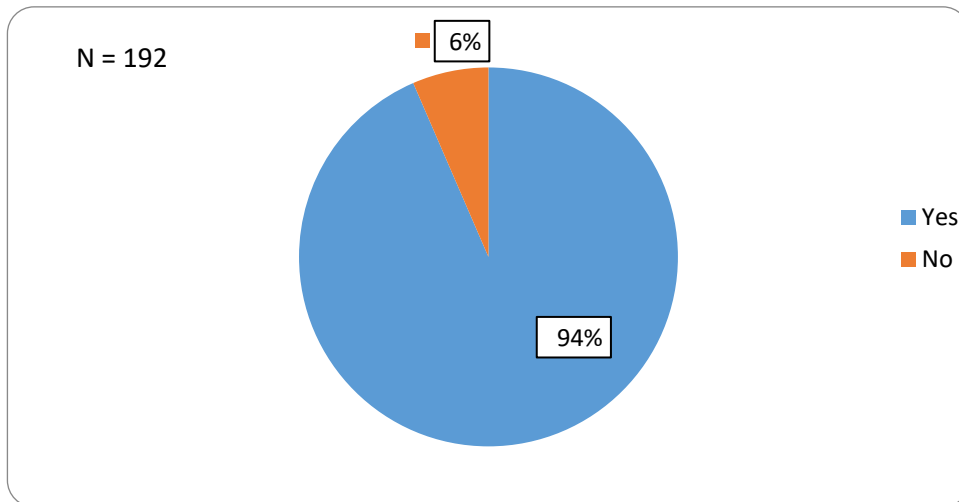
Household questionnaires were used for collecting data from fish farmers (n = 192) and non-fish farmers (n = 192). A Key Informant interview and Focus Group Discussion guide were used to collect data from the key informants and fish farmers in order to understand their utilization of fish as food. Secondary data was obtained from textbooks, theses, journals, annual reports, statistical abstracts as well as the internet search [3].

Analysis of Variance (ANOVA), Chi Square test and correlation analyses were used to test whether there were differences between fish farmers and non-fish farmers in terms of their household food security and livelihoods. The correlation coefficient computed between variables was interpreted by comparing its magnitude with its probable error. The probable error of the coefficient of the correlation is obtained using the following formula:  $P.E._r = 0.6745 \frac{1-r^2}{\sqrt{N}}$

When r is less than P.E.<sub>r</sub> there is no evidence of significance, meaning the value of r is not statistically significant (P>0.05). On the other hand, when the value of r is greater than six times the probable error, the coefficient of correlation is significantly different from zero (P<0.05) [11]. From the measurement of the mid upper arm circumference (MUAC) of children, a correlation coefficient was calculated to establish if there is a relationship between malnutrition and fish farming or non-fish farming.

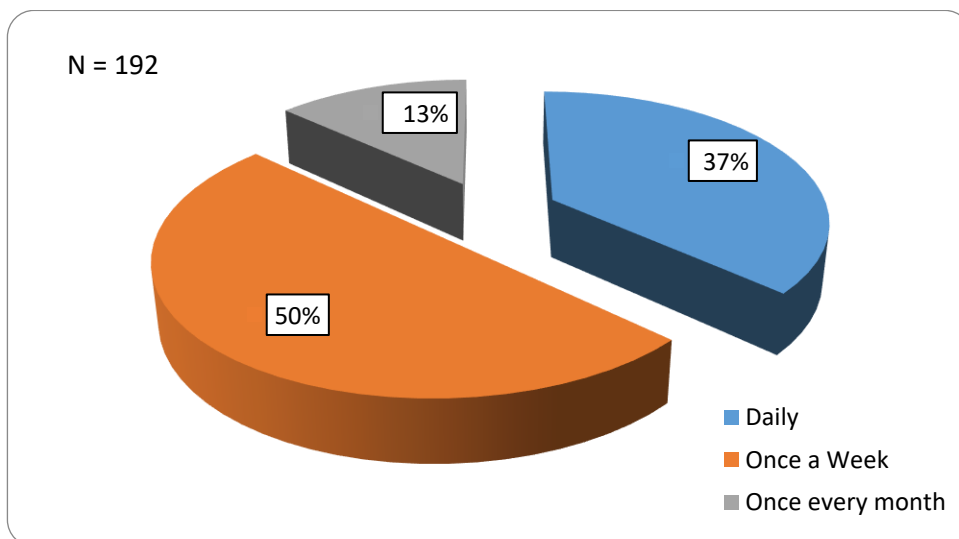
## RESULTS

Fish farming contributes significantly to food security status among fish farming and non-fish farming households. Utilization of fish within households: Fish was a major component in the diet for most fish farmers (Figure 2). Majority (94%) of fish farmers had fish in their diet while 6% did not have fish as a major dietary component. Differences in responses were significant ( $\chi^2_{1,0.01} = 290.51; P < 0.01$ ).



**Figure 2: Fish as a major dietary component for fish farmers of Siaya County, Kenya**

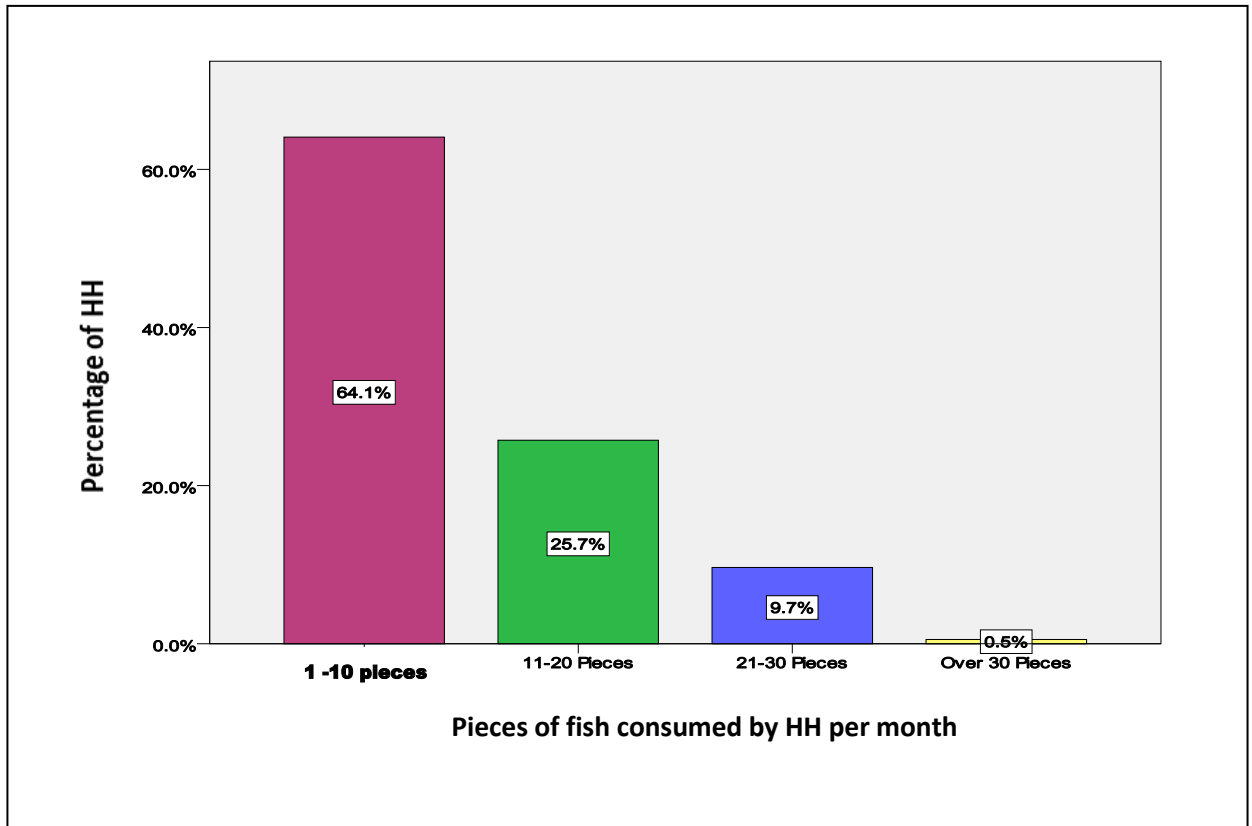
Frequency of consumption of fish in the household: At least 13% of fish farmers had fish in their diet once every month and another 50.0% once a week while 37% consumed fish daily (Figure 3), an indication that fish was commonly consumed in the households. Differences in regularity of fish consumption were significant ( $\chi^2_{2,0.01} = 36.24$ ;  $P < 0.01$ ).



**Figure 3: Regularity in the inclusion of fish in household's diet by fish farmers in Siaya County, Kenya**

An examination of harvested fish used for household consumption showed that majority (64.1%) of fish farmers consumed 1-10 pieces, 25.7% consumed 11-20 pieces, 9.7% consumed 21-30 pieces while 0.5% consumed more than 30 pieces of fish per month

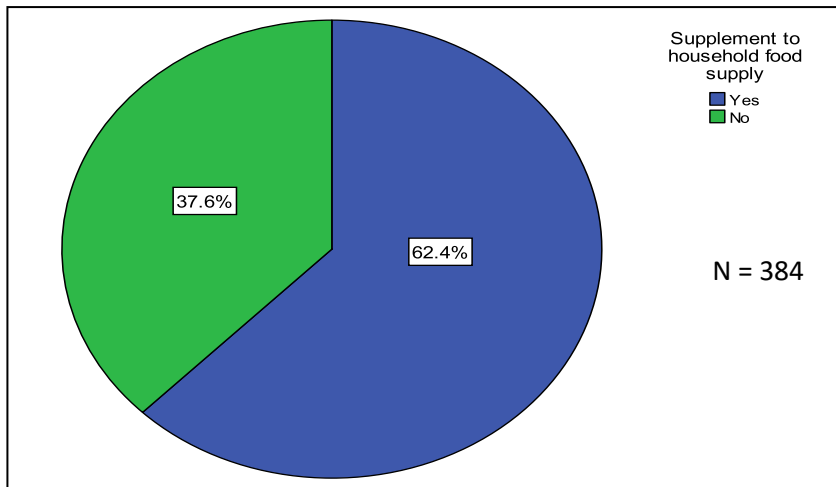
(Figure 4). This suggests that fish consumption is regular in households involved in fish farming. It is thus likely that fish farming has a role in enhancing household food security. The results further indicate that despite the respondents being involved in fish farming, some were not eating sufficient amount of fish in their households regularly.



**Figure 4: Amount of harvested fish used for household consumption in Siaya County, Kenya**

Key: HH- Household

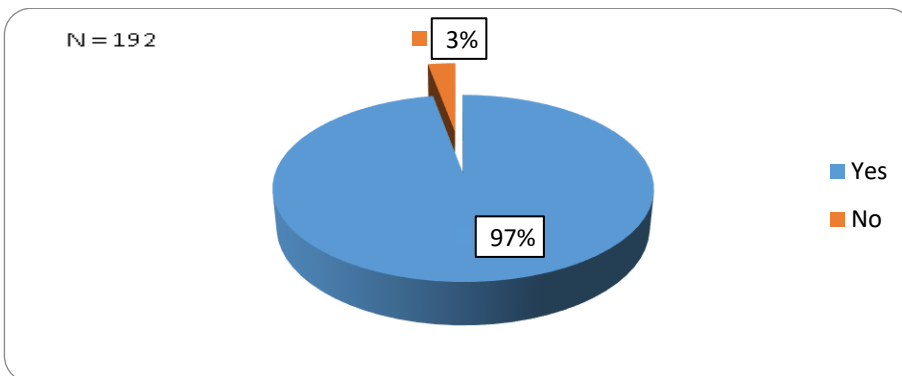
Arising from this factor at least 37.5% fish farming household indicated fish had not supplemented their household food supply, while 62.5% indicated fish had supplemented their household food supply (Figure 5).



**Figure 5: Fish as a supplement of household food supply in Siaya County, Kenya**

#### **Fish farming as a source of income**

Most (97.1%) fish farmers sold their fish to get income while a few (2.9%) practised fish farming for household consumption (Figure 6).

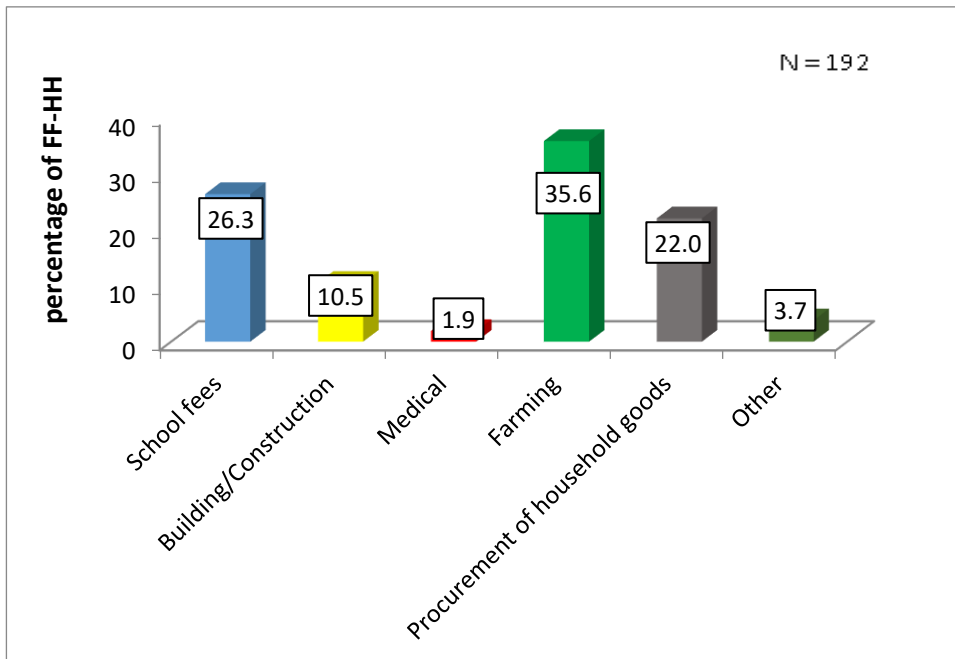


**Figure 6: Fish farming as a source of income for fish farmers in Siaya County, Kenya**

#### **Use of the income generated from fish farming**

On average, 3.7% of proceeds was used for uses such as travelling and entertainment, 26.3% was used on school fees, 10.5% was used on building and construction, 1.9% used for medical services, 35.6% for farming and 22.0% used for procurement of household goods (Figure 7).

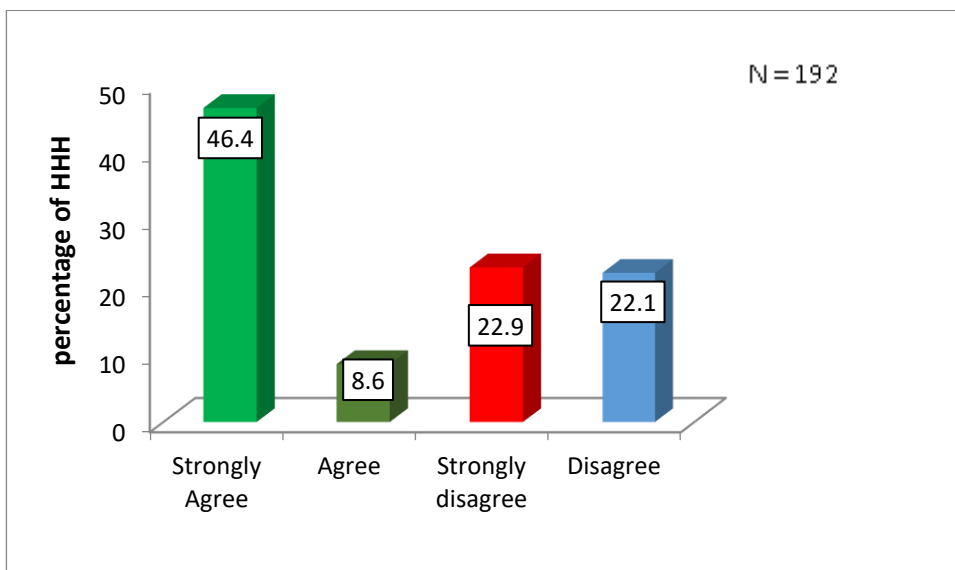




**Figure 7: Use of income generated from fish farming by fish farmers in Siaya County, Kenya**

Key: FF-HH: Fish Farming Households

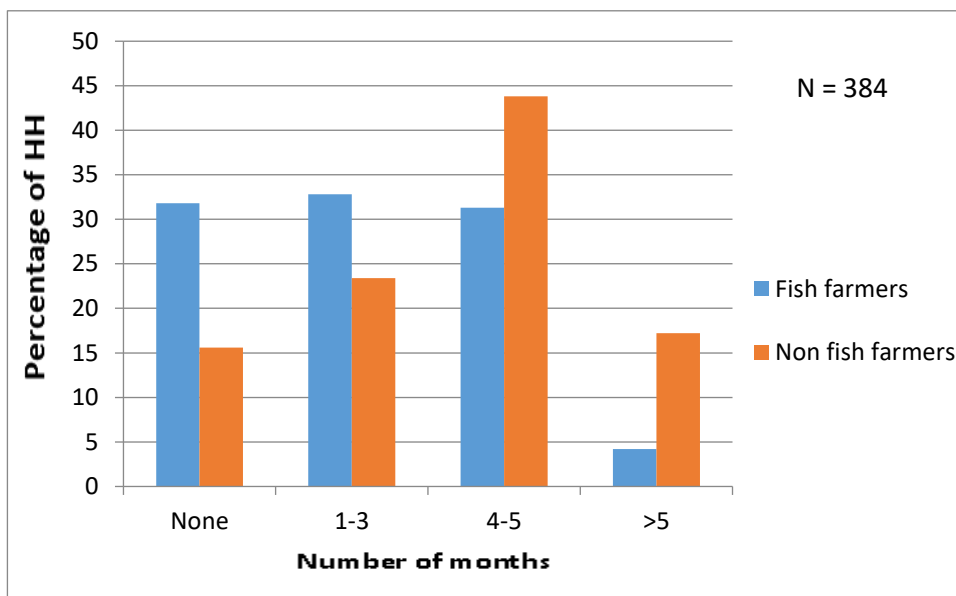
Majority of fish farmers (55.0%) agreed that the payback from fish farming was worth the investment. However, a considerable proportion (45.0%) were of the view that the payback from fish farming was not worth the investment (Figure 8).



**Figure 8: Perception of economic Worth of fish farming by Households in Siaya County, Kenya**

HHH – Household Head

A one-way ANOVA showed significant ( $p < 0.01$ ) difference in the number of months of serious food shortages between fish farmers and non-fish farmers. Non-fish farmers faced more months of serious food shortage as compared to fish farmers (Figure 9). Among the non-fish farmers, 15.6% faced no month of serious food shortages, 23.4% faced 1-3 months, 43.8% faced 4-5 months while 17.2% faced more than 5 months of serious food shortages. For fish farmers, 31.8% faced no month of serious food shortage, 32.8% faced 1-3 months, 31.3% faced 4-5 while only 4.2% faced more than 5 months of serious food shortages.



**Figure 9: Months of serious food shortages for fish farmers and non-fish farmers in Siaya County, Kenya**  
HH – Household

There are a couple of possible explanations. Fish farming could have improved household diet. Alternatively, fish farmers may have higher incomes (fish farming requires initial capital to enter the industry), and this could be the cause of the improved food security. Some fish farmers were not adequately benefiting from their fish farming enterprises due to the many constraints faced.

### Nutritional Assessment for children under five years

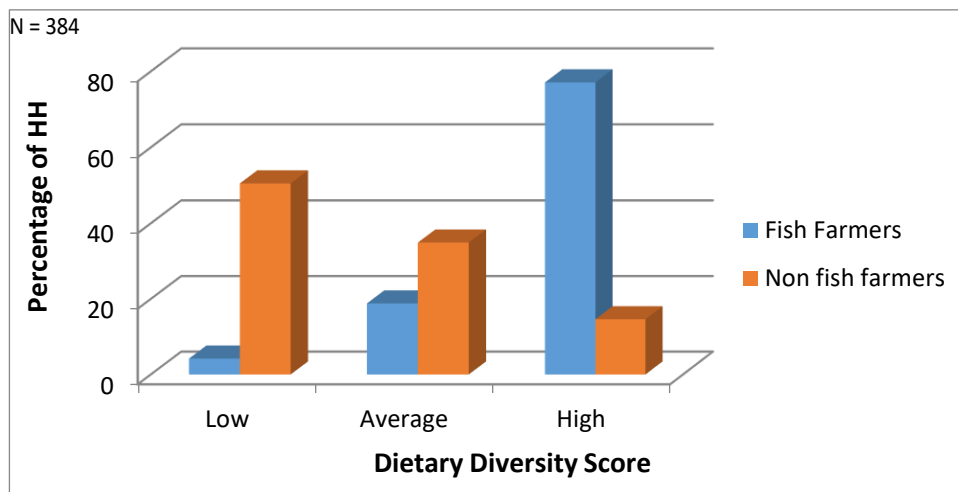
Nutritional status of pre-school children among fish farmers and non-fish farmers was determined by measurement of the mid upper arm circumference (MUAC). Of children sampled from households practicing fish farming, 83.1% were well nourished, 13.3% were at risk of malnutrition while 3.6% were malnourished. Among Non-fish farming households, 50.6% were well nourished, 36.1% were at risk of malnutrition while 13.3% were malnourished (Table 2). Children of non-fish farmers were found to be relatively more malnourished than those of fish farmers. However, the Chi Square test of

association for independence of variables showed no significant difference ( $\chi^2_{4,0.01} = 0.448$ ;  $p > 0.05$ ).

### Body Mass Index (BMI) for lactating mothers from fish farmers' and non-fish farmers' households

Chi Square test of independence conducted between the body mass index (BMI) for lactating mothers among fish farming and non-fish farming households showed significant difference ( $\chi^2_{9,0.01} = 59.54$ ;  $p < 0.01$ ).

Lactating mothers from fish farming household were found to have a higher Body Mass Index (BMI) compared to non-fish farming households (Table 3). From fish farming households, 11.1% mothers were underweight, 72.2% had optimal weight and 13.0% were over-weight while 3.7% were obese. For those from non-fish farming households, 68.5% were underweight, 24.1% had optimal weight and 5.5% were overweight while 1.9% were obese.



**Figure 10: Dietary Diversity Score among fish farmers and non-fish farmers in Siaya County, Kenya**  
HH- Household

A one-way ANOVA on dietary diversity score for households between fish farmers and non-fish farmers showed significant difference ( $p < 0.05$ ).

Most of the fish farmers had access to a wide variety of foodstuffs compared to non-fish farmers because fish farmers had a high food diversity score than non-fish farmers who rated low (Figure 10). At least 4.2% fish farmers had low food diversity score while non-fish farmers were 50.5%. For average food diversity, fish farmers were 18.8% while non-fish farmers were 34.9%. High food diversity score was represented by 77.1% of fish farmers while 14.6% were non fish farmers.

## DISCUSSION

Utilization of fish within households practicing fish farming was high as it formed a major dietary component of their daily dietary intakes; however, in few households practicing fish farming, fish was not a major component of their diet.

Focus Group Discussions' (FGDs') findings showed that the launch of the Economic Stimulus provided technical and financial assistance to households in Siaya County to encourage them to engage in fish farming for food security and income generation, a concept that was taken up by some households but not others, therefore, fish was well utilized as food by households that took up fish farming.

### **Amount of harvested fish used for household consumption**

An examination of harvested fish used for household consumption on a monthly basis showed that majority (64.1%) of fish farmers consumed 1-10 pieces, 25.7% consumed 11-20 pieces, 9.7% consumed 21-30 pieces while 0.5% consumed more than 30 pieces of fish (Figure 4). This suggests that fish consumption is regular in households involved in fish farming. It is thus likely that fish farming has a role in enhancing household food security. The results further indicate that despite the respondents being involved in fish farming, some were not eating sufficient amount of fish in their households regularly.

Siaya Fisheries District Officer and the in charge of Millennium Fisheries Project stated that most fish ponds belong to men who never allowed their wives or children to fish from them before harvest time. It also emerged that, at harvest time the men sold most of the fish leaving little for family consumption. This is because most men carried out fish farming as a source of income but not for household food consumption. This could explain reasons why not enough fish is consumed at household level in the county. This is an indication that fish was playing a role in the availability and diversity of food.

### **Fish farming as a source of income**

According to Australia Centre for International Agricultural Research-ACIAR [1] in rural areas farmers raise fish as a supplementary enterprise to growing crops. A portion of the output is retained for household consumption and the residual is sold in local markets to provide an additional source of income. Farmers living on low incomes have been reluctant, however, to raise fish as a formal farm enterprise because of high feed costs and low survival rates of fingerlings.

From Focus Group Discussions (FGDs), most households carried out fish farming as a source of income especially where the males dominated while little was reserved for household consumption. Readily available market both at farm gate and local markets motivated the farmers to sell most of their fish. This is similar to Nepal where small scale fish farming through active participation of women is a good income generating opportunity for rural communities and a livelihood option for people having small holding of land and living in poverty [4]. In Ogun State Nigeria, fish farming is economically rewarding and profitable [2]. It is capable of creating employment, augmenting income and improving the standards of living of the people.



### **Use of the income generated from fish farming**

Most household heads reported that they had used income from fish farming to: purchase farm inputs, pay school fees, procure household goods among many other benefits, which concurred with reports from FGDs. Farmers in suitable areas across the country are turning to fish farming as a way of producing high quality food, either for their families or for the market, and as a way of earning extra income [7]. Recent locally conducted research and on-farm trials by the Ministry of Agriculture have enabled farmers to learn application of appropriate techniques and good management practices resulting in high yields and a good income to supplement their daily budgets.

### **Worth of Payback from Fish Farming**

From FGDs, it emerged that the high cost of running the enterprise was mainly due to the high cost of feeds and predators. District Fisheries Officers (DFOs) who were key informants observed that reduced payback from fish farming was as a result of poor management practices by fish farmers where fish at harvest were small and stunted attracting low prices on the market. An issue arose with some fish farmers and DFOs claiming the scale used to measure fingerlings at some hatcheries was not as claimed, because almost all ponds stocked with 1000 fingerlings, measure at most 600 mature fish when harvested in both mono and mixed sexes ponds at maturity. This low number of fish at harvest reduces the payback.

### **Meal Frequency per day before and after beginning of fish farming**

Fish farming has a positive impact on the food security status of fish farming households (Table 1). A one-way ANOVA established significant difference ( $P < 0.05$ ) in the number of meals eaten per day before and after beginning fish farming.

Fish farming had enabled many fish farmers to reduce the number of months in which they faced serious food shortages. Some fish farmers were not adequately benefiting from their fish farming enterprises due to the many constraints faced.

From FGDs, fish farmers used fish as food as well as income obtained from the sale of fish to purchase other food stuffs hence increasing the amount of food in stock for their households. Australian Centre for International Agricultural Research (ACIAR) impact assessment report confirms that there was significant food security and poverty alleviation benefits for the farm households that operate a fish-farming enterprise [1]. Income gains varied according to the amount of fish retained for home use. There were also human health benefits from improving the nutritional content of the family diet through increased consumption of fish.

### **Nutritional Assessment for children under five years**

Fish farming offers tremendous opportunities for Kenya [9]. By increasing fish farming productivity and production, there is subsequent increase in food security for both domestic and external markets. This has led to improved incomes and wealth for households, unemployed youth, fish traders, fish processors, and inputs suppliers in the fish farming value chain. This has in essence confronted head-on Sustainable Development Goals (SDGs) Number 1 and 2 which seek to eradicate extreme poverty

and hunger world-wide [9, 11]. It has addressed the issue of better nutrition for the fish farming households and others, tackling Millennium Development Goals (MDGs) Number 4, 5 and 6 which seek to reduce child mortality, improve maternal health care and combat malaria, HIV/AIDS and other diseases through improved nutrition and improved health status [12].

## CONCLUSION

Results pointed out that fish was a major dietary component for most fish farming households (93.5%) and was regularly included in farmers' household diets. In addition, fish farming was a stable source of income through the sale of harvested fish. The results further indicated that fish farming had positively and significantly influenced the number of meals eaten per day for fish farmers. Similarly, majority of fish farmers reported a reduction in the number of serious food shortages after they began fish farming [13]. A one-way ANOVA also showed that there was a highly significant ( $p < 0.01$ ) difference in the number of months of serious food shortages between fish farmers and non-fish farmers with non-fish farmers having more months of serious food shortages. Similar results were obtained on the nutritional status of pre-school children, BMI for lactating mothers and dietary diversity [14]. Children from fish farmers' households were well nourished as compared to those of non-fish farmers.

Fish farming should be adopted as one of the realistic approaches in not only alleviating perennial food insecurity but also poverty in its totality. Having displayed remarkable nutritional status among the populations of fish farming households, it is a high time that fish eating is not only promoted in all households but also more households are enabled to participate in fish farming. However, due to the capital needs higher income households are more likely to be able to enter the industry. The need to empower the women to participate in fish farming through training needs to be implemented to optimize fish farming benefits to the individual households. Fish is a very perishable and delicate food product that requires not only elaborate storage but also processing facilities at the farming point.

**Table 1: Impact of fish farming on number of meals eaten per day for fish farmers' households in Siaya County, Kenya (n = 192)**

Number of meals/day	Before		After	
	Frequency	%	Frequency	%
Once	49	25.5	21	10.9
Twice	101	52.6	33	17.2
Three times	38	19.8	78	40.6
Four times	4	2.1	60	31.3

**Table 2: Nutritional status for children under five years for fish farmers and non-fish farmers in Siaya County, Kenya**

Nutritional Status	Fish Farmers		Non fish farmers	
	Frequency	%	Frequency	%
Well Nourished	69	83.1	42	50.6
At risk of malnourishment	11	13.3	30	36.1
Malnourished	3	3.6	11	13.3
<b>Total</b>	<b>83</b>	<b>100.0</b>	<b>83</b>	<b>100.0</b>

**Table 3: Body mass index (BMI) for lactating mothers for fish farmers and non-fish farmers in Siaya County, Kenya**

BMI	Fish Farmers		Non Fish Farmers	
	Frequency	Percent	Frequency	Percent
Underweight	6	11.1	37	68.5
Optimal	39	72.2	13	24.1
Overweight	7	13.0	3	5.5
Obese	2	3.7	1	1.9
<b>Total</b>	<b>54</b>	<b>100.0</b>	<b>54</b>	<b>100.0</b>

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