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Effect of Social and Economic Drivers on Success of Small Scale Fish farming in Western Kenya.

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Abstract
Aquaculture in Kenya provides important livelihood opportunities for the rural poor by improving the local economy as well as supplementing protein sources. Despite being one of the areas with highest aquaculture potential in the country, Western Kenya records some of the highest rates of poverty and malnutrition. This study undertook an assessment of socio-economic factors affecting small scale fish farmers in this region. Structured questionnaires were administered to 135 households through direct interviews. The relationship between fish production and variables affecting it were modeled using a multiple linear regression. The results revealed that access to road infrastructure was the most significant ($p=0.00239$) factor affecting fish production in the study area. Other significant factors of production include pond management level ($p=0.01452$), source of water for fish farms ($p = 0.02029$), fish feed ($p=0.02241$), status of fish ponds ($p=0.0289$) and location of ponds ($p=0.029$). Therefore policy planning for aquaculture development should strongly consider these factors as an important aspect of fish farming.

Keywords: Aquaculture, Household, Production, Socioeconomics

Introduction
There is increasing demand for fish products related to the rising global population, and the growing preference for fresh foods for human consumption. This is a huge challenge in a world where more than 800 million people are threatened with chronic malnutrition and fisheries sector has to play a role in the provision of vital proteins and essential nutrients (FAO, 2014). Worldwide fish products support the livelihoods of more than 530 million people (OECD, 2014). The current human consumption of farmed fish has overtaken that provided from the capture fishery which has reached its limits. Therefore the future of global fish supply lies in aquaculture that currently accounts for almost half of the world fish food production and is projected to contribute more than 60% of fish for human consumption by 2030 (FAO, 2014; Kobayashi *et al*., 2015).

The global aquaculture has been expanding at a rate of 6.2% in the last decade (FAO, 2014) with Asia accounting for the bulk of the global production (Bacher, 2015). Aquaculture growth is credited with stimulating the development of rural communities (Asche, 2008; FAO, 2012) and is recognized for the provision of important livelihood opportunities for the rural poor by addressing social and economic issues such as poverty, employment and food security (Kaliba *et al*., 2007; Béné *et al*., 2015). Understanding aspects of socio-economic variables influencing small holder fish farming is crucial for public support and participation in the aquaculture industry (Kundu, 2010; Obiero *et al*., 2014; Bacher, 2015). In Africa, introduction of aquaculture for social objectives was done in the 1950s as a diversification of farm activities to cushion against uncertainties in crop production (Hetch, 2006). The African Union identifies fish farming as a great potential for promoting rural economies and supports National economic policies and aquaculture strategy programmes of Member States in tackling poverty and food insecurity in Africa (NEPAD, 2005).

Fishing and aquaculture supply in Kenya, currently stands at 168,400 MT valued at KSh. 22.4 billion contributing 0.7% to GDP (Government of Kenya, 2016). The supply consists of productions from the inland fisheries (80.3%), marine capture (5.4%) and aquaculture (14.3%) sub-sectors (Government of Kenya 2014). Aquaculture was introduced in the 1900s, and underwent a slow pace of development partly attributed to limited knowledge on performance of various aquaculture systems in the country (Ngugi & Manyala, 2004; Kaliba *et al*., 2007) and lack of a relevant policy to guide the promotion and investment in the sub-sector. For almost half a century after Independence, the Kenya Fisheries Department operated on Ministerial Guidelines issued on *Ad hoc* basis and a fisheries statute (Kenya Fisheries Act Cap 378) that had no policy direction. However towards the end of the 2000-2010 decade, fish farming picked up after the national government invested massively in the sub sector under the Fish Farming Enterprise Productivity Program funded through the National Economic Stimulus Program (ESP) that enabled the increase of aquaculture production from1000 MT per year to over 20,000 MT per year within a few years (Aloo, 2011; Munguti, *et al*., 2014a; Government of Kenya, 2014). The ESP was driven by the need to spur rural development, and significantly contribute to poverty alleviation through income generation, creation of jobs, and enhanced food security (Aloo, 2011; Musa *et al*., 2012). The increase in production is expected to hit 100,000 MT by 2030 through diversification from the current traditional earthen ponds to mariculture, cage farming and expansion to Arid and Semi-Arid Lands (Charo-Karisa & Gichuri, 2010; Government of Kenya, 2012).

In order to ensure a successful and sustainable development of aquaculture as an imperative agenda for the national economy, the Government developed the National Aquaculture Policy, 2011 and National Aquaculture Development Strategy to counter the declining production from capture fisheries. A fully-fledged Directorate of Aquaculture Technology Development was also established in 2013 under the Kenya Ministry of Agriculture, Livestock and Fisheries to enhance aquaculture development.

The *Constitution of Kenya, 2010* created two levels of Governments (National and County Governments) and recognizes the importance of natural resources and their use for posterity. The *Constitution* provides for specific functions for the two levels of Government as they relate to the fisheries sector. Aquaculture is a function of the

Devolved Governments whereas the National Government provides policy direction in the administration of aquaculture. The Fisheries Act (Cap 378) of 1989, Fisheries Regulations (1991) and the Maritimes Zones Act (CAP 371) of 1989 are the principal statutes that regulate and govern the fisheries sector besides the National Oceans and Fisheries Policy, 2008. To take into account the socio- economic and political changes at the devolved, and national levels as it relates to the fisheries sector, the National Oceans and Fisheries Policy, 2008 and Fisheries Act (Cap 378) are under review for better governance of the sector. A key Fisheries Management and Development Bill has been passed in Parliament and once enacted into law, it is expected to revolutionize the sub-sector to a higher level.

Western Kenya is one of the areas with highest aquaculture potential in the country because of abundance of water resources. Since the 1970s, the Region has attracted remarkable attention from international development agencies (FAO, UNDP, World Bank and USAID-Aquafish CRSP), to assist resource poor households earn livelihoods through small scale fish farming. However the region still records some of the highest rates of poverty and malnutrition at national level ((FAO, 1996; Ngugi & Manyala, 2004). Therefore the potential to develop and expand aquaculture in Busia, one of the western County is high. Sectoral contribution to household income is heavily reliant on wage employment 45.3%, and agriculture 35.4%. Fish farming dates back to the late 1960s and early 1970s. The first phase of ESP established 1, 200 fish ponds in Busia County with a surface area of 360,000 m². Absolute poverty stands at 66.7%, food poverty 61.4% and hardcore poverty 50.64 % (Government of Kenya, 2013). The County has a rich history of fish eating based on fishing mainly undertaken in Lake Victoria (137 km² of permanent water surface in the County), and other marshy areas near the lake. The capture fishery is dominated by Nile perch (*Lates niloticus),* Omena (*Rastrineobola argentea)* and Nile tilapia (*Oreochromis niloticus*). According to Lake Victoria National Frame Survey 2014 report, the County has about 3000 registered fishers and over 1200 fishing boats operating at 28 fish landing sites. There are 250,000 assorted fishing gears of which 94% (235,000) are long line hooks targeting the Nile perch for export market. The long line fishery offers incentive for development of a vibrant bait fishery based on catfish.

Materials and Methods

The study was conducted in Busia County located in Western Kenya, bordered by Bungoma County to the northeast, Kakamega County to the east, Siaya County to the southeast, The Republic of Uganda to the west and of Lake Victoria in the south (Figure 1). The County covers 1,628.4 km² with a total population of 743,946 and population density of 439/km² (Government of Kenya, 2013). The County has mean annual rainfall of 1500 mm, temperatures ranging from 22ºC to 30ºC and fertile soils with high retention capacity (Jaetzold *et al*., 2007).

The study was undertaken from October 2007 to March 2008, before the implementation of the ESP. This was a period characterized by inadequate promotion and support by the national government in fish farming and low incentives on production inputs to attract investors in the sub-sector. A total of 135 fish farming households were selected using a simple random design in five administrative units of Bunyala, Samia, Butula, Nambale and Matayos Sub-Counties (latitude 0º 1´ 36´S 0º 33´N and longitude 33º 54´ 32´´E and 34º 25´ 24´´E).

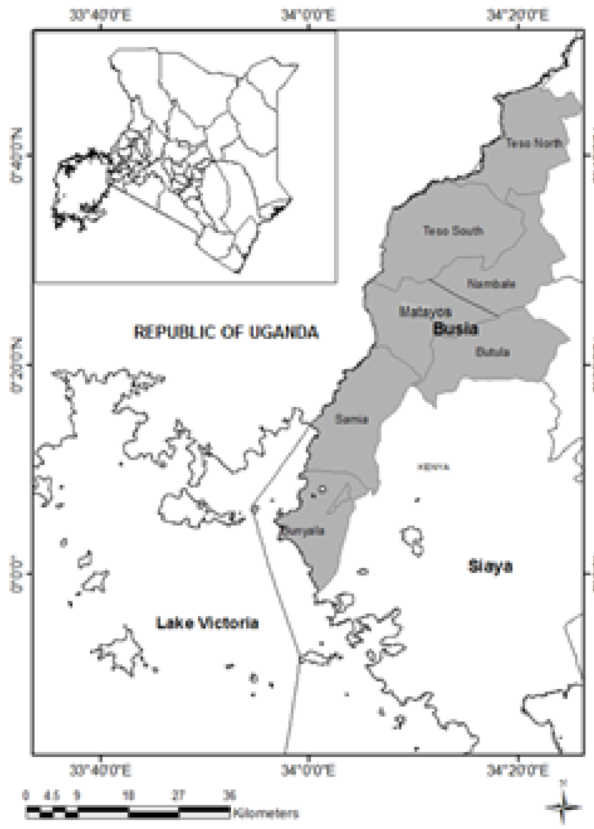

Figure 1: Map showing the study area, Busia County, Kenya

The fish farmers were interviewed face-to-face using an open-ended questionnaire. Data collected included demographic characteristics of respondents, factors affecting fish farming and constraints to performance of the fish ponds. Descriptive statistics was used to describe socioeconomic characteristics of respondents using Statistical Package for Social Sciences (SPSS) computer program. The relationship between fish production and variables affecting it were modeled using multiple linear regression in a statistical computing language and environment R 3.1.0 (R Development Core Team, 2014).The model input parameters were as follows:

lm (formula = Production ~ Age + County + Education + Electricity + feeding + Finger source + Gender + Household size + Landownership + Land size + Location + Marital status + Pond management level + Occupation + Pond location + Records + Roads + Species + Pond status + Training + Water source + Year started).

Fish farming household was used as a unit of analysis because it is at this level that major decisions relating to production are made. A household was considered as defined by FAO (1999) to be a group of people living on the same farm, who work together on at least one parcel of land and recognize the authority of a single head of house hold in major decisions relating to the farm activities.

Results

The demographic structure of the interviewed fish farmers is given in Table 1. The fish farming community was male dominated. Household size varied from 1 to 40 with a mean of 10 persons per household. Majority of the respondents had primary education while a minority had tertiary education. The main occupation of heads of households was peasant farming. Most of the other respondents were small scale traders, housewives/widows, masons, public servants and fish mongers.

Table 1: Social characteristics of respondents

Item	Characteristics	Percentages	Frequency
Gender	Male	88	118
	Female	9	12
	Group	3	4
Age (years)	15-20	3.1	4
	21-25	3.1	4
	26-30	7.8	10
	31-35	11.6	15
	36-40	12.4	16
	41-45	8.5	11
	46-50	16.3	21
	51-55	10.8	14
	56-60	10.8	14
	61-65	7.8	10
	> 66	7.8	10
Marital status	Married	78.1	100
	Polygamy	12.5	16
	Single	2.4	3
	Widow	7	9
House hold size	5 and below	6	22
	6 to 10	37.3	57
	11 and above	56.7	38
Education Level	Non	14.3	16
	Primary	47.3	53
	Secondary	29.4	33
	College	6.3	7
	University	2.7	3
Land Ownership	Single	60.8	73
	Family	31.7	38
	Trust	4.2	5

More than half of the respondents (52.5%) owned land they resided on, while 13.7% of the respondents did not disclose land ownership. The smallest land parcel sampled was 0.1 ha while the largest was 7.3 ha, and the average land size was 2.1 ha. The survey results showed fish farmers had a variety of sources of starting capital. Some respondents (38%) without starting capital employed unskilled collective/community labour to construct their fish ponds (Figure 2). However 24% had their starting capital from savings. The other sources of starting capital were farm sales, 9%, grants, 6% and loans, 4%. The remaining 15% households inherited the fish farms from their parents on ancestral land.

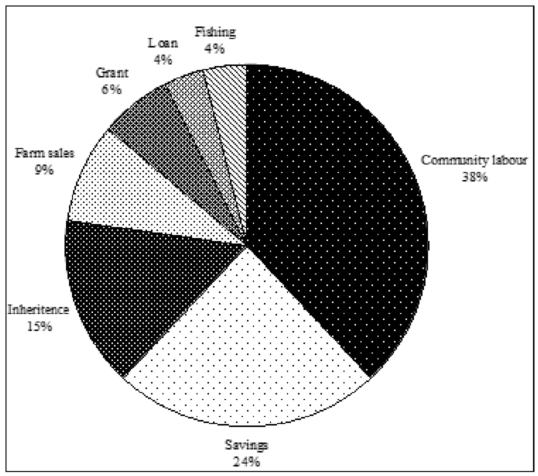

Figure.2: Sources of starting capital for the fish farmers in Busia County.

Households in the survey used farm based materials as fish feed. These included materials such as sweet potato and cassava leaves, kales and weeds, all accounting for 45%, termite ants (21%), kitchen leftovers (10%), and slaughter wastes (7%). The remaining 18% comprised of other feeds (Omena dust - *Rastrineobola argentea*), sun dried freshwater shrimp *Caradina niloticus* (ochong'a), rice bran, maize bran and growers marsh**.** The survey showed that 51% of the respondents stocked their ponds on the basis of supplies from other farmers while 37%, sourced fingerlings from government institutions. The rest of the respondents got their fingerlings from the wild (lake, swamps and rivers).

Most respondents (40%) interviewed practiced partial harvest of their fish ponds using either hook and line or seine netting. On the other hand, 30% practiced both total (by draining ponds) and partial harvests, while 4% of the respondents practiced total harvest. However, 26% of the respondents were yet to harvest their ponds. Potential yields or economic output of majority of these farms could not be ascertained partly because of the fact that the main techniques of harvesting resulted in only partial catches.

Table 2 gives a summary of characteristics of ponds in the study area. Majority of the ponds are located away from the homestead near streams and swampy areas. The main source of water for the ponds was from springs (79.5%) through gravity. The most common farming types were monoculture of tilapia (43.2%) and African catfish (15.2%). Polyculture of the two species was practiced by 24% of the respondents. A small number of the respondents reared African marbled lungfish (*Protopterus aethiopicus*). About a third of the respondents believed that it was taboo to culture the marbled lungfish and spiny eel fish (*Mastacembelus frenatus*) species.

The study revealed that the average fish production was 797.6 ± 117 kg $ha^{-1}yr^{-1}$. The lowest production was 47 kg $ha^{-1}yr^{-1}$ and the highest was 5936 kg $ha^{-1}yr^{-1}$ (Table 3). Over 75 % of the respondents produced less than 1000 kg $ha^{-1}yr^{-1}$ out of which 48% produced 100 kg $ha^{-1}yr^{-1}$ or less. The average pond size in the study area was 147 km^2.

Table 2: Characteristics of ponds owned by fish farmers in Busia County

Item	Characteristics	Percentages	Frequency
No. of ponds owned	1	50.4	68
	2	31.1	42
	3	9.0	12
	4	7.3	10
	5	1.5	2
	7	0.7	1
Pond location	Away home	88.3	106
	Adjacent home	11.7	14
Year of construction	1960-1970	5.1	6
	1971-1980	5.1	6
	1981-1990	10.2	12
	1991-2000	21.2	25
	After 2000	58.4	69
Water source	Spring	79.5	101
	Stream	13.4	17
	Borehole	1.6	2
	Irrigation	1.6	2
	Lake	3.9	5
Pond status	Active	65.2	86
	Inactive	22.7	30
	Abandoned	10.6	14
	Under construction	1.5	2
Management level	Semi-intensive	42.3	41
	Extensive	57.7	56
Species cultured	Catfish	15.2	19
	Tilapia	43.2	54
	Tilapia/catfish	24.0	30
	Lungfish	0.8	1

Table 3: Fish production among respondents interviewed in Busia County

Production (kg $ha^{-1}yr^{-1}$)	Frequency	Percentage (%)
100 and less	59	48.0
101-300	17	13.8
301-1000	17	13.8
1001-2000	16	13.0
2001-3000	9	7.3
3001-6000	5	4.1

The projected cost of constructing and operating an economically viable fish pond of 300 m^2 over a period of 240 days as per the government regulations and prevailing wage rates was KSh 73,863.75. Pond construction accounts for 28.5% of the total cost (Table 4).

Table 4: Cost of developing and running a 300 m² fish pond in Busia County (8months)

Investment	Item	Activity	Description	KSh
Capital costs	Labour	Pond construction	10men*2m^{3}soilday^{-1}@KSh140.45 man^{-1} day^{-1}*15days	21,067.5
		Manuring	1man*1hrwk^{-1}@KSh 26 hr^{-1} *32wks	832
		Feeding	1man*2hr day^{-1}@KSh 26 hr^{-1} *224days	11,648
		Harvesting	5men*2hr @KSh 26 hr^{-1} man^{-1}	260
		Stocking	2men*1hr@KSh 26 hr^{-1} man^{-1}	52
	Tools	Construction tools	5jembes@KSh 450, 5spades@KSh 400, 2pangas @KSh 350 each	4,950
	Maintenance	Pond maintenance	10% of capital investment	3,880.95
		Sub total		**42,690.45**
Variable costs	Inputs	Fingerlings	3m^{-2}*300m^2 = 900 @KSh 3pc^{-1} plus 10% to cater for mortality	3,000
		Fertilizer	DAP 2g m^{-2} wk^{-1}*32wks =19.2kg @KSh 32 kg^{-1}	614.4
			Urea 3g m^{-2} wk^{-1}*32wks =28.8kg @KSh 26 kg^{-1}	748.8
		Agricultural liming	20kg100m^{-2} = 60kg @KSh 10 kg^{-1}	600
		Feeds	Maize/rice bran (feeding rates)	
			1st -2nd month, 0.9kgday^{-1}@KSh 4.3kg^{-1}* 30days	116.1
			2-3rd (2.7kg day^{-1}@KSh 4.3kg^{-1}* 30days)	348.3
			3-5th (2.7kg day^{-1}@KSh 4.3kg^{-1}* 60days)	696.6
			5-8th (3.6kg day^{-1}@KSh 4.3kg^{-1}* 90days)	1,393.2
			8th (4.5kg day^{-1}@KSh 4.3kg^{-1}* 30days	580.5
		Fishing Net	1@KSh 1,000	1,000
		Sub total		**9,097.9**
Security costs	Pond security	Hiring watchman	1man @ KSh 2,771 month^{-1}* 8months	22,168
		Sub total		**22,168**
			Grand total	**73,863.75**

Exchange rate 1 USD: 66 Kenya Shillings (2007)

An estimate of cost and return analysis of a similar theoretical model pond of 300 m² reveals that variable costs accounts for 66.4% of the total cost of fish farming in Busia in one cropping (Table 5). Other farm activities undertaken by respondents alongside fish farming included (in order of priority): maize (22%), cassava (21%), sugar cane (12%) potatoes (11%) sorghum and vegetables 7% each among others.

A multiple regression model on production and other variables was strong and significant ($R^2= 0.84$, $F= 7.82$, $DF=29$, $p= 5.20e\text{-}07$). The Model output is shown in Table 6. Access to roads was the most significant ($p = 0.00239$) factor affecting fish production in the study area. Other significant factors of production include pond management level ($p = 0.01452$), source of fish farm water ($p = 0.02029$), fish feed ($p = 0.02241$), pond status ($p =0.0289$) and location of ponds from homestead ($p =0.029$).

The major challenges facing fish farmers included lack of quality fingerlings and fish feeds, harvesting nets, theft, predation, lack of capital, inadequate extension services and land

Table 5: Enterprise budget for 300m² pond in Busia County, under semi-intensive management, stocked at 3 fish/m² (assuming 10% mortality) and fed on cereal by-products for 8 months

Item	Description	Unit	Quantity	Price/Unit (KSh)	Total cost (KSh)
Gross Receipts					
Tilapia	Live	Kg	225	400	90,000
Total Gross Receipts					90,000
Variable Costs					
Tilapia finger lings	Hatchery-raised	Individual	1,000	3	3,000
Pelleted diet	15% crude protein	Kg			3,134.7
Fertilizer	Urea	Kg	28.8	26	748.8
	DAP	Kg	19.2	32	614.4
Agricultural Lime	Lime	Kg	60	10	600
Field labour: stock, feed, fertilize, harvest		Hours	492	26	12,792
Labour, pond repairs after draining		KSh	152	84.16	12,792
Security personnel		Month	8	2771	22,168
Interest on operating capital		KSh			3,881
Total Variable Costs (TVC)		KSh			59,731
Net Returns above TVC		KSh			30,269
Fixed Costs					
Depreciation					
Equipment		KSh			495
Ponds		KSh			2,106.75
Interest on Investment		KSh			2,602
Total Fixed Costs (TFC)		KSh			5,204
Total Costs (TC)		KSh			64,935
Net returns above TC	300m² pond	KSh			**25,065**
*Net returns above TC/ha/yr		KSh			**834,664.5**
Break even price per kg					
Above TVC		KSh			**265.5**
Above TC		KSh			**288.6**

Discussion

The study showed that although both men and women participate in fish farming, men mainly dominate the enterprise. One possible reason for gender disparity in fish farming is land ownership which is traditionally a patrilineal affair in Western Kenya. Local culture allows only sons to inherit land from parents. Therefore this makes women have little say on allocation of farm activities on family or ancestral land. However, besides the disadvantage position, it was observed during this study that women in Busia play a significant role in the production process of fish farming. Their services in the provision of labour in gathering, preparation and delivery of home/farm-based fish feed to ponds is a clear demonstration of their social responsibility within the household and contribution towards the day-today running of fish farms. The results of this study compares favourably with the findings of Ride (2014) and Monfort (2015), that gender differences in access rights to land resources and lack of empowerment are key factors undermining the role of women in fish farming in the developing world. Addressing these inequalities as well as putting in place policy measures that elevate the decision-making roles of women will improve their participation in aquaculture.

Table 6: Multiple linear regressions Model output on variables related to fish production in western Kenya.

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	7.8458	3.56417	2.201	0.03504	*
Age	-0.01281	0.09222	-0.139	0.89042	
County	0.28459	0.22029	1.292	0.20566	
Education	-0.16992	0.2713	-0.626	0.53555	
Electricity	0.09258	1.36975	0.068	0.94653	
Feeding	-0.45377	0.24425	-1.858	0.02241*	
Finger source	-0.04336	0.10287	-0.421	0.67622	
Gender	-1.03221	0.75949	-1.359	0.18362	
Household size	-0.49689	0.27959	-1.777	0.08504	.
Land ownership	-0.38608	0.45122	-0.856	0.39856	
LandSize.acr.	0.20431	0.31237	0.654	0.51774	
Marital status	-0.45377	0.24425	-1.858	0.07241	.
Pond Mgt level	-0.94904	0.36722	-2.584	0.01452	*
Occupation	0.01916	0.03833	0.5	0.62068	
Pond location	-1.27322	0.55688	-2.286	0.029	*
Records	-0.27973	0.40989	-0.682	0.49986	
Roads	1.7993	0.54548	3.299	0.00239	**
Species	-0.03436	0.26096	-0.132	0.89608	
Status	-0.92612	0.40479	-2.288	0.0289	*
Training	-0.13299	0.26837	-0.496	0.62359	
Water source	-1.13723	0.46561	-2.442	0.02029	*
Year started	-0.17268	0.13537	-1.276	0.21126	

Significance codes: 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1. Residual standard error: 1.204 on 32 degrees of freedom Multiple R-squared: 0.6775; Adjusted R-squared: 0.4356; F-statistic: 2.801 on 24 and 32 DF; *p-value: 0.003479*

The *Constitution of Kenya 2010*, encourages affirmative action, thus recognizes gender equity in access to ancestral land empowering women to have rights and authority over land use. The current constitutional dispensation therefore addresses traditional and social norms and attitudes to a more encompassing situation, which fully motivates and provides opportunity for women to play an integral part in rural development and enhance their contribution in poverty alleviation, generation of incomes and nutrition at household level through small scale fish farming.

The age of a fish pond may not matter in terms of fish yields when the necessary management measures are in place. However in this study it was observed that over 50% of the fish ponds surveyed were constructed after the year 2000. One of the reasons cited by the households was the declining fish supplies from Lake Victoria. In order to supplement the scarce fish protein that is in high demand, most people focused on small-scale fish farming for home consumption and also to generate some income at the household level. This observation is similar to that reported by Abila (2003), that fish available from Lake Victoria has been declining due to demand for international trade. As such fish supply for domestic consumption is inadequate (Geheb *et al*., 2008). Therefore to counter the scarcity of fish from the capture fishery, farmers in Busia adopted small scale fish farming to cushion themselves from spiraling fish prices that are beyond reach of the rural poor (Odongkara *et al.*, 2005) and also contribute to household food security. Another possible explanation could be the implementation of the World Bank supported Kenya Agricultural Productivity Project (KAPP) which started after the year 2000. The project aimed at sustainable agricultural productivity, empowering and improving farmer's livelihoods through an integrated and synchronized approach in research and extension (KAPP, 2007).

Generally the study revealed that fish pond yields in the County were low averaging 797.6 kg $ha^{-1}yr^{-1}$. This paltry production compares unfavorably with the national mean of 5840 kg $ha^{-1}yr^{-1}$ realized in other Regions of the country. This could be attributed partly to small sizes of ponds that are not economically viable. Owing to the pressure on land, fish farming enterprise competes with other agricultural activities (such as small scale horticulture of kales and cabbages, cultivation of maize, beans, sugarcane and cassava and pasture for livestock) within limited space. It was observed that fish ponds occupied a small fraction of the total land owned by the respondent households and therefore the size of the ponds depends on size of the land parcel.

Road network is important in small scale fish farming because of faster delivery of perishable products to the market and accessing inputs for the fish farm. In commercial aquaculture profitability of the fish farming venture will depend on transaction costs related to the efficiency of the road network. This study revealed significant relationship between access to roads and fish production. This implies that basic infrastructure like roads and mode of transport has a bearing on delivery of inputs like fingerlings by reducing stress and mortality on the input. Busia County falls within the Sugar belt zone and benefits from an extensive feeder-road-networks maintained by Sugar manufacturing companies operating in the Region. These results are consistent with surveys done on smallholder fish farms in Uganda (Jagger & Pender, 2001), which showed that the type of road network has an effect on overall fish pond production in rural fish farming.

The source of water for the fish pond was found to significantly affect production. Water quality is the first most important limiting factor in pond fish production. It is also the most difficult production factor to understand, predict and manage. Water is not just where the fish live, its quality directly affects feed efficiency, growth rates, the fish's health and survival. Most fish kills, disease outbreaks, poor growth, poor feed conversion efficiency and similar management problems are directly related to poor water quality as also noted by Kareem et al. (2009). Almost eighty percent (79.5%) of the fish farms covered in the survey received water from springs through gravity with a near constant flow throughout the year. This factor assured continuous operations of the fish farms.

The level of pond management i.e the type of production system either as extensive (no inputs and little or no attention to pond maintenance after initial stocking, characterized by poor yields) or semi-intensive (supplementary feeding, pond manuring and regular pond maintenance, produces average to good yields) was the most significant factor affecting production. Well managed ponds exhibited higher fish production than unattended ones. Good management is important for maintaining optimal conditions for fish survival and growth. Pond management goes hand in hand with the available resources for investing in the fish farming enterprise. In this study, it was evident that fish farmers with some alternative income (civil servants, traders, fish mongers and craftsmen) practiced semi-intensive aquaculture and their pond production was relatively higher than those that practiced extensive farming with little input. The farmers with alternative sources of income are able to acquire inputs like fingerlings from established institutions and afford to hire quality labor for harvesting the ponds.

Fish farm production is a function of various inputs used including feeds (significant factor) and fertilizer (not significant) to improve the fish biomass and fertility rate of the fish ponds. It was observed that farm based products formed the basis of fish feeds in the County. However, the nutritive quality of the farm based feed was not assessed and quantified to determine its impact on fish production during this study. The preference of farm-based products could be related to their ease of access and affordability. The application of termite ants as a complimentary feed offers a good source of energy for the growing fish. But owing to the current pressure on land for agriculture, its source and sustainability is not guaranteed.

The application of supplementary commercial feed with known nutritive value was restricted to very few respondents who could afford the costs. Studies in Central Kenya have shown that supplementary feeding on high protein feeds is important for improving yields in fish pond culture (Liti *et al*., 2005). From the results of this study, it is evident that prohibitive costs, denies fish farmers accessing quality feed which is a contributory factor to the poor performance of small-scale fish farming in Western Kenya. According to Munguti et al. (2014b) and Kobayashi et al. (2015), the future expansion in aquaculture relies largely on improvements on feed quality in terms of nutrition and digestibility and the cost effectiveness of feeding practices.

Pond fertilization was basically organic manure from livestock and poultry, readily available for use in the fish farms. The manure is either derived from household's own reared animals in the homesteads or from neighbours on goodwill. Organic manure in fertilized ponds provides natural nutrients which are key for fish growth. This study shows the importance of by-products from other economic activities in small scale fish farming among rural households who cannot afford to buy inorganic fertilizers.

It is worth noting that inputs such as fingerling quality and availability did not prove significant to production in this study, but it is a key element in pond management. Although stocking of ponds forms a basic step in aquaculture production by providing the initial biomass, it was observed that most fish ponds visited were not stocked on a regular basis. It was observed that because of limited knowledge on stocking rates, fish farmers tended to either under or overstock their ponds. Such fish farms are not viable and lower the economic potential of the fish farming activity. Although availability of fingerlings is not a problem, there are only two government institutions in the County that may produce reliable quality seed. They include Wakhungu Fish Farm in Samia Sub-County and Lake Basin Development Authority hatchery at Alupe in Teso South. Lack of sufficient and good quality fingerlings seriously limits the growth and development of fish farming in the Region. Fingerlings sourced from fish farmers are actually stunted tilapia with unknown age adding little value to the fish farming enterprise. Likewise, fingerlings collected from the wild do not guarantee quality and continuous supply. The supply from the rivers was found to be inadequate and normally limited because availability is seasonal, coinciding with flooding periods.

Capital is important for a viable fish farm enterprise. It is necessary for purchase of fish farm equipment, good quality seeds and feeds, hire of farm hands and expanding existing fish farm enterprises. It was observed that community (collective) labour was important during pond construction and it was common among households with interests in smallholder fish farming. It is an economic strategy aimed at minimizing initial capital and also circumvents the cost of hiring skilled labour for constructing ponds. Socially, community labour in the spirit of African socialism offers a safety net to assist vulnerable groups in society without a sound financial base to sustain their livelihoods. This togetherness therefore is a form of social capital that bonds people to achieve a common goal. These observations are consistent with results of studies done in Rwanda by Hishamunda and Jolly (1998) where sharing farm labour minimized costs through collective action among small-scale fish farmers. Inheritance of fish farms was found to occur when the head of the household dies and the ponds are taken over by either the widow or one of the children. Under such circumstances the new pond owner does not incur initial production costs but only sources for resources for expansion or maintenance.

This study showed that for a household owning a 300 m² pond size in Busia County incurs an average total cost of KSh. 64,935 in a cropping season. Revenue generated from this farm in the season is KSh. 90,000 with a net farm income of KSh. 25,065. This result indicates that adopting a 300 m² as the minimum size of pond in small scale fish farming is profitable. The cost and benefit analysis of this model pond is based on prevailing government labour rules and price of commodities during the study (Government of Kenya, 2006) and on the assumption that the fish is harvested at an average weight of 250 grams/piece. However, changes in government policies after the post-election violence in 2008 had a significant bearing on labour regulations and prices on inputs such as fish feed and fertilizer making it more expensive to develop a fish farm. The cost of inputs shot-up and hired labour under ESP cost KSh 250/person/day compared to KSh 140.45 in 2007.

Theft was also identified to be a major constraint partly because most of the ponds are constructed at distant sites (near wetlands) from the homesteads making them easy target by thieves. This form of predation had a negative effect on performance and production of fish farms. A possible explanation for the rampant theft could be related to the poverty levels and food insecurity among the rural population in the County. Despite several efforts by the National government to tackle the problem of poverty, the general poverty level in Busia County is very high at 64.2% compared to the national poverty level of 45.9% (Anon, 2016). As a strategy to minimize theft, some fish farming households encouraged unemployed youths in the neighbourhood to start fish farming, thereby avoid getting into crime.

Land as a resource is becoming scarce due to fragmentation related to inheritance and population pressure which poses a serious limitation to expansion of farm enterprises. Returns from such land can become high if improved aquaculture practices are adopted. It was observed during the survey that the issue of fish farming potential in land-constraint areas of the County had forced a number of households to establish small-scale fish ponds in swampy areas and river banks. Such fish ponds faced risks of being swept during flooding and poses threat to the hydrological functions of the wetlands.

Lack of enough extension officers and logistics to deliver technical knowledge about fish farming to households may partly be responsible for the poor returns from fish farming in the County. The shortage of extension staff is attributed to the governments' embargo on employment and staff rationalization in the public service (Wandera, 2012). However the contribution of other development agencies like quasi-government institutions and National Universities is recognized in the County though some of the institutions operate in isolation from the local fisheries office. According to Ngugi and Manyala (2004), inadequate dissemination of information and poor linkage between research and extension has undermined aquaculture growth in Western Kenya.

Pillay (1996) noted that sustainable fish farming must be socially acceptable and the species being farmed must conform to the general cultural, norms of the community to avoid social resentment. Although the local population in Busia has a well-established culture of fish consumption it is believed among the elderly members of the community that it is taboo to culture the African marbled lungfish and spiny eel, because tradition forbids women from eating them. It is believed that women who eat marbled lung fish end up developing enlarged breasts while the eel is avoided because of its snake-like shape. This implies that local beliefs regarding the two species has some influence on the peoples' perception towards culturing them.

Conclusions and Recommendations

Understanding the factors influencing the development of aquaculture is critical in planning. It was against this background that this study was conducted in Western Kenya which lies within one of the high potential areas for aquaculture development as well as high poverty levels in the country. The study showed that policy variables such as roads infrastructure, fish feed, pond management and water are important determinants of fish pond production. It is therefore important to strengthen the identified areas of policy concern to improve fish farming in Western Region and Kenya at large.

While this study may form baseline information on some aspects of social and economic factors affecting fish farming, the findings underscores the need for a post-ESP research to access newest knowledge on the influence of social and economic parameters on the performance of aquaculture in Kenya under the current constitutional dispensation. Fast tracking the reviewing of the current National Fisheries Policy to strengthen Public Private Partnership to provide opportunities for fiscal benefits through subsidy in addressing issues related to key inputs like quality fish feed and seed. This will provide incentives to make aquaculture a growth engine of socio-economic development among rural communities. The role of women in aquaculture is important and therefore there is need to increase gender sensitivity in awareness programs related to aquaculture. As we try to address the socio-economic challenges affecting the sub-sector at household level, it is further recommended that development of aquaculture is viewed in a wider perspective by comparing its performance vis-a-viz other competing agricultural production systems.

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