World Journal of Fish and Marine Sciences 6 (3): 245-251, 2014
ISSN 2078-4589

DOI: 10.5829/idosi.wjfms.2014.06.03.83240

Assessment of the Socio- Economic Value of Aquaculture in the West-Nile Agro Ecological Zone of Uganda

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Abstract: This work examines the costs, returns and constraints affecting aquaculture production in the West-Nile region of Uganda. A sample of 36 fish farms in the districts of Maracha, Zombo, Arua and Koboko were purposively selected for this study, however for the assessment of profitability, only 20 farms were considered. Data was collected in 2012 production season through administration of questionnaire to the fish farmers. Analysis of the data was done using descriptive statistics and budgeting technique. The data revealed that on average a small scale fish farmer in West Nile incurs 81.3% of the variable costs and 18.7% of the fixed costs with the majority of the variable costs attributed to feeds and fingerlings. The comparison of performance across the four districts using average values of the net farm incomes indicate that aquaculture is a profitable enterprise that on average, a fish farmer in Maracha district earns a higher net profit of Shs. (Uganda shillings) 2,444,393 compared to a farmer who earns Shs. 1,111,314 for Koboko, Shs. 809,536 for Arua and Shs. 407,169 for Zombo in a production cycle that ranges between 7-12 months. Although the results show that on average, a small scale fish farmer making profits, the estimated net profits are relatively small. The main factors identified as hindrances to aquaculture development in the study region included expensive feeds, inadequate financial capital, lack of technical knowledge and insufficient farm equipments. It is recommended that the government should venture or even encourage other investors into the production of good quality and affordable feeds and fingerlings to reduce on the huge variable costs incurred by farmers.

Key words: Aquaculture · Costs · Fish Farmers · Net Profit · Uganda · West-Nile

INTRODUCTION

Aquaculture has been identified by the Ugandan Government as means of improving the food and nutrition security situation of the country and also contributing to household incomes in rural areas. However, the current level of aquaculture production of 10,000 tons annually as established by Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) [1] does not meet both local and external market demand. Despite the political support, lack of knowledge concerning returns from aquaculture investment has contributed significantly to slow growth of the aquaculture sector in many parts of the country especially the West-Nile region of Uganda. Therefore, fish farming is seen as a marginal and risky investment.

Historically, aquaculture was introduced to Uganda as a non-traditional farm technology in the late1950's [2, 3]. During that time, there were high levels of kwashiorkor among children in the Central region. Fish farming was therefore introduced by the Fisheries and Game Department as means of providing cheap animal protein that could easily be accessible to rural subsistence households. It was also seen as a way of increasing the availability of fresh fish to communities that lived a distance from the country's natural water

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bodies. The Fisheries Experimental Station, Kajjansi (now the Aquaculture Research and Development Center) was therefore established in 1953 so as to develop appropriate low-budget production technology that could be undertaken by subsistence rural households to produce fish as a dietary supplement [3, 4].

The Government of Uganda has set a goal of meeting the country's requirements for fish through increased aquaculture production to a projected 300,000 tons by 2016. This plan has been captured in the Agriculture Sector Development and Investment Plan for 2010-2015, which has prioritized fish commodity as one of the top investment opportunities over the medium term [5]. However, in the West-Nile region, aquaculture is currently responsible for an insignificant proportion of total fish production yet there is increasing demand for fish in the neighboring countries of South Sudan and Democratic Republic of Congo coupled with threats to the supply of fish from the Lake Albert and River Nile fish catches. This region is also endowed with water resources and variety of fish species. While most of the efforts have been oriented towards the technical development and implementation of fish rearing techniques, no attempts have been done to establish the profitability of fish farming in the West Nile Agro-Ecological zone of Uganda. Yet understanding the economic profitability of aquaculture is important as it guides government, development partners and farmers in making decisions important in promoting and investing in fish farming [6]. Due to limited availability of economic data, the reluctance of farm owners and managers in providing costs and returns data, evaluation of economic opportunities in aquaculture in West-Nile region has been rendered difficult. It is against this background that the present study was undertaken to assess the profitability and also identify the opportunities and constraints of fish farming in the West-Nile region of Uganda.

This study estimated fish farming profitability through analysis of the costs and revenues as described by Hyuha *et al.* [6] who applied the same analysis in understanding the profitability performance of small scale aquaculture enterprises in Central Uganda. In addition, Engle *et al.* [7] also applied the same analysis to demonstrate how Rwandan aquaculture in correctly managed ponds provides cash to the family and supplements the diet. Kudi *et al*. [8] also employed the same budgeting technique to understand the economics of fish production in Kaduna state of Nigeria. Profitability analysis is therefore such an important management tool necessary for business planning, seeking financial assistance from formal institutions and identifying economically sustainable enterprises [9].

MATERIALS AND METHODS

Study Area: The survey was carried out in the districts of Koboko, Maracha, Arua and Zombo. The selection of these districts enabled a fair representation of all the fish farming communities in West-Nile region. Based on information provided by the fisheries departments of the districts, a total of 36 fish farms were surveyed. The purposive method of sampling was used in the selection of farmers practicing fish farming.

Budgeting Technique: The budgeting technique employed was the net farm income. The estimates included profits in the form of cash receipts (revenues) and costs associated with the production cycle of usually 7-12 months to small-scale fish farming in West-Nile region of Uganda. The computed margins were calculated as described by Hyuha *et al*. [6].

$$GM = TR - TVC \quad (1)$$

where, GM = Gross Margin; TR = Total Revenue; TVC = Total Variable Cost

$$\text{Net Farm Income (NFI)} = GM\text{-}TFC \text{ or } TR\text{-}TC \quad (2)$$

Where, TFC= Total fixed costs; TC=Total costs

$$\text{Net Return on Investment (NROI)} = NFI/TC \quad (3)$$

Depreciation: It was taken into account by using the declining balance method over an estimated period of 10 years. It was based on initial investment made by the farmer and the tools/equipment acquired.

Data Collection and Analysis: The survey instrument used both closed and open-ended questions depending on the type of information desired. Direct personal interviews were conducted at farmers' residences at appointed time or at the farmer's convenience. Approximately one to two hours were spent with each interviewee. Data collected through direct interviews were supplemented with individual pond records kept by the farmers. Data was checked for consistency before

analysis. Entry and recording errors were amended. Comparisons between answers to related questions enabled checking for consistency. Data analysis was done using Statistical Packages for Social Sciences (SPSS).

RESULTS

Socio Demographic Characteristics: Most of the respondents interviewed were males and constituted 83.3% while 11.7% of the respondents were females (Table 1). Majority of the farmers interviewed had attained some level of education. 33.3% of the people interviewed had attained primary level of education, 12.5% had secondary level of education, 37.5% had attained tertiary level of education and 16.7% of the respondents had no formal education.

Feed Resouces Used by Farmers: Among the fish farms visited, majority of the fish farmers (50%) use local feeds comprising of mainly cassava, potatoes, maize grain, vegetable leaves and kitchen leftovers (Figure 1). About 21% use commercial pelleted fish feeds. Other types of feeds used included mukene/fish meal (20%) and blood meal (9%).

Gender and Fish Farming: The study found that men are mostly responsible for the decisions to initiate fish farming (52%) and harvesting of fish (41%). The women mainly play a key role in the decision on when to consume fish in the household (63%) while the decision on the use of proceeds from fish sales is jointly taken by both men and women in the household (67%). Table 2 summarizes gender roles in decision making.

Marketing: In all the farms that were surveyed, 97.2 % farmers market their fish in its fresh form. Another important observation is that the fish is mostly sold at farm gate price (63.6%) and only (36.4%) farmers able to take their harvest to the village or urban markets in the region.

Fish Species Reared: It was also found that the farmers rear a variety of fish species both in monoculture and polyculture production systems. The most common fish species reared by farmers were Nile tilapia (54.6%) and African catfish (36.4%). Fingerlings are sourced within the region as well as outside the region as far as Kajjansi

Table 1: Demographic characteristics of respondents

Variable	Percentage
Sex	
Male	88.3
Female	11.7
Educational level	
No education	16.7
Primary education	33.3
Secondary education	12.5
Tertiary institution	37.5

Table 2: Gender and decision making

	Decision making (%)		
Items	Men	Women	Both
Start of fish farming	52	22	26
Harvest of fish	41	22	37
Eating of fish at home	30	63	7
Use of income from fish sales	30	3	67

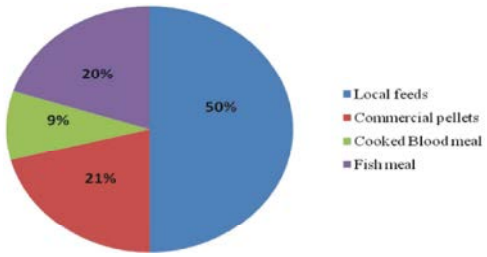

Fig. 1: Common feeds utilized by farmers

Aquaculture Research and Development Center. 86.4% of the farmers obtained fish fingerlings through their respective district fisheries departments while 13.6% obtained fingerlings from Kajjansi-Aquaculture Research and Development Center. Nearly all the farmers interviewed cultured fish in ponds rather than cages. The length of the production cycle (from stocking to harvest) ranged between 7 to 12 months.

Constraints: A summary of the reported constraints is reported in Table 3. The most constraints facing fish farmers in the zone include expensive feed, lack of technical knowledge in fish farming, inadequate financial capital and inadequate supply of fingerlings.

Expensive Feeds: This was identified to be the most serious constraint to fish production as reported by 100% of the respondents.

Lack of Basic Equipments and Harvesting Nets: This problem accounted for 91.6% of farmers in the study area. Most of the farmers borrow basic equipments from the district fisheries offices when it is time to harvest fish.

Table 3: Constraints facing fish farmers in the study districts (*n=36)*

Variable	Number of respondents	Percentages*
Expensive fish feeds	36	100
Inadequate supply of quality fingerlings	20	55.5
Thieves	5	13.8
Lack of technical knowledge	25	69.4
Lack of basic equipments and harvesting nets	33	91.6
Water shortage during drought	10	27.7
Inadequate financial capital	25	69.4
High maintenance costs	5	13.8
Predators	4	11.1

*Percentages do not add to 100 due to multiple responses.

Table 4: Estimated costs and returns of individual farms

District	Koboko					Maracha			
Fish farm	1	2	3	4	5	6	1	2	3
Number of ponds	1	6	4	2	2	1	2	4	1
Revenue (Ushs)									
Yield / harvest (kg)	600	1,500	360	214.5	125	340	48.5	389	138.5
Price of fish / kg	5,000	10,000	5,000	7,000	12,000	6,000	4,500	9,000	7,000
Income Table fish	3,000,000	15,000,000	1,800,000	1,501,500	1,500,000	2,040,000	218,250	4,500,100	969,500
Income-Fingerlings	0	10,000,000	0	0	0	0	220,000	6,500,000	0
Total	3,000,000	25,000,000	1,800,000	1,501,500	1,500,000	2,040,000	438,250	11,000,100	969,500
Variable costs (Ushs)									
Fingerlings	900,000	3,000,000	1,300,000	900,000	340,000	830,000	125,000	840,000	150,000
Fertilizer	0	600,000	0	0	0	120,000	0	240,000	0
Feeds	120,000	6,250,000	125,000	520,000	432,000	520,000	105,000	1,670,000	124,000
Labour costs	252,000	2,550,000	245,000	155,000	222,000	340,000	209,000	335,000	260,000
Total	1,272,000	12,400,000	1,670,000	1,575,000	994,000	1,810,000	439,000	3,085,000	534,000
Fixed costs (Ushs)									
Depreciation (ponds)	10,731	81,703	15,993	8,790	16,276	21,123	13,629	20,617	12,425
Tools	50,000	7,800,000	0	18,000	130,000	300,000	210,000	525,000	235,000
Total	60,731	7,881,703	15,993	26,790	146,276	321,123	223,629	545,617	247,425
Net farm income	1,667,269	4,718,297	114,007	-100,290	359,724	-91,123	-224,379	7,369,483	188,075

Exchange rate: US$ 1 =Uganda shillings 2,545

Table 4: Continued

District	Zombo					Arua					
Fish farm	1	2	3	4	5	1	2	3	4	5	6
Number of ponds	1	6	4	2	2	7	4	3	3	1	3
Revenue (Ushs)											
Yield / harvest (kg)	91.5	623	158	146	180	822.3	200	116	107	70	141
Price of fish / kg	5,000	4,500	6,000	7,500	6,000	7,500	6,000	7,500	3,000	4,000	6,000
Income Table fish	457,500	2,803,500	950,000	1,095,000	1,080,000	6,167,250	1,200,000	870,000	321,000	210,000	846,000
Income-Fingerlings	0	0	0	0	0	2,250,000	0	0	0	0	350,000
Total (Ushs)	457,500	2,803,500	950,000	1,095,000	1,080,000	8,417,250	1,200,000	870,000	321,000	210,000	1,196,000
Variable costs (Ushs)											
Fingerlings	100,000	474,000	60,000	200,000	200,000	1,200,000	250,000	180,000	135,500	50,000	250,000
Fertilizer	0	0	30,000	30,000	0	0	0	0	0	0	0
Feeds	200,000	595,000	324,800	420,000	472,000	960,000	240,000	315,000	180,000	245,000	381,000
Labour costs	130,000	295,000	320,000	160,000	234,000	700,000	120,000	98,000	160,000	40,000	200,000
Total (Ushs)	430,000	1,364,000	734,800	810,000	906,000	2,860,000	610,000	593,000	475,500	335,000	831,000
Fixed costs (Ushs)											
Depreciation (ponds)	6,984	15,090	8,106	9,411	10,762	27,924	12,591	12,919	5,363	2,308	9,930
Tools	0	5,000	0	0	50,000	1,200,000	0	350,000	26,500	0	5,000
Total (Ushs)	6,984	20,090	8,106	9,411	60,762	1,227,924	12,591	362,919	31,863	2,308	14,930
Net farm income	20,516	1,419,410	207,094	275,589	113,238	4,329,326	577,409	-85,919	-186,363	-127,308	350,070

Exchange rate: US$ 1 =Uganda shillings 2,545

Table 5: Profitability results for a small-scale fish farm in West-Nile region of Uganda

District		Ushs	US$
Koboko	Total costs (TVC+TFC)	4,695,603	1845.03
	Total revenue (TR)	5,806,917	2281.70
	Gross margin (TR-TVC)	2,520,083	990.21
	Net farm Income (GM-TFC)	1,111,314	436.67
	Net return on investment (NFI/TC)	0.23	
Maracha	Total costs (TVC+TFC)	1,691,557	664.66
	Total revenue (TR)	4,135,950	1625.13
	Gross margin (TR-TVC)	2,783,283	1093.63
	Net farm Income (GM-TFC)	2,444,393	960.47
	Net return on investment (NFI/TC)	1.4	
Zombo	Total costs (TVC+TFC)	870,031	341.86
	Total revenue (TR)	1,277,200	501.85
	Gross margin (TR-TVC)	428,240	168.27
	Net farm Income (GM-TFC)	407,169	159.99
	Net return on investment (NFI/TC)	0.47	
Arua	Total costs (TVC+TFC)	1,226,173	481.80
	Total revenue (TR)	2,035,708	799.89
	Gross margin (TR-TVC)	1,084,958	426.31
	Net farm Income (GM-TFC)	809,536	318.09
	Net return on investment (NFI/TC)	0.66	

Exchange rate: US$ 1 =Uganda shillings 2,545

Lack of Technical Knowledge: In all the fish farms which were surveyed, 69.4% of the farmers reported to lack technical knowledge in fish farming. Except for the farmers hosting Abi Zonal Agricultural Research and Development Institute experiments, most of them ventured into the enterprise as a result of seeing other fellow farmers practicing fish farming.

Inadequate Financial Capital: 69.4% of the farmers reported being unable to obtain the necessary inputs due to inadequate finances.

Inadequate Supply of Quality Fingerlings: This was another serious problem as reported by 55.5% of the farmers. Many farmers complained of poor fingerlings which in some instances did not grow to the farmers expectations.

Profitability Analysis

Costs: The costs and returns results for individual farms in the West-Nile region are reported in Table 4. Primary inputs identified and required in the production process were seed, fish feed, fertilizer and production labour. The data revealed that farmers in all the districts incurred higher variable costs (81.3%) than fixed costs (18.7%) with the majority of the variable costs attributed to feeds and fingerlings (Table 4). The higher variable costs observed in this study is comparable to that of central Uganda reported at 92.8% and fixed cost at 7.3% by Hyuha *et al*. [6].

Returns: The profitability results across the districts are reported in Table 4, indicating that on average, a small scale fish farm in koboko district generated net farm income of Shs. 1,111,314, Maracha generated Shs. 2,444,393, Zombo generated Shs. 407,169 and Arua generated Shs. 809,536 during the 2012 production cycle. Since all the net farm incomes were positive across the districts means that aquaculture is profitable in West-Nile region and worth undertaking. In addition, the estimated net return on investment in all districts was positive (Table 5). This indicates that for every 1 Uganda shilling invested in small scale fish farming, Shs 0.23 is generated in return for Koboko, 1.4 for Maracha, 0.47 for Zombo and 0.66 for Arua district (Table 5). Although positive for Koboko and Zombo, the observed net returns on investment in these districts are still low while that of Maracha is quite satisfactory.

DISCUSSION

The cost and availability of inputs including fry and purchased feed are the key factors defining the relative profitability among the fish farms [6, 10, 11]. In this study, the issue of expensive feed was identified as serious problem leading to high production cost and even leading to some farmers to abandon their fish ponds. In the end, some farmers have resorted to use maize bran, which is believed to be of poor quality and as a result, poor fish growth rate is expected. This problem is made worse since there is no nearby outlet for fish feeds in the region. Apart from local feeds, farmers have to purchase manufactured feeds all the way from the central part of Uganda and the associated transport costs make the feeds much more expensive for a small scale farmer. This finding has a big implication for aquaculture development in West-Nile region therefore, fish farmers must closely follow prices and have contingency plans in cases when feed costs rise faster than market price. The problem of feed reported in this study is in agreement with the findings of Hyuha *et al.* [6] who found that expensive feeds was a serious constraint to fish production in central Uganda. Ugwumba and Chukwuji [11] also studied the economics of catfish production and reported that high cost of feeds contributes to a very serious constraint to fish production in Nigeria.

The relatively higher net profit experienced by fish farms in Maracha district is because of the presence of kochi fish farm that breeds and sells fish fingerlings to farmers in the district at a reduced price. Farmers in this district have access to fingerlings compared to other districts. In addition, the farmers are able to keep records so that assessment of the fish performance is easier in each cycle. As Killan *et al*. [12] reported that records for fish farming provide source of information by which farmers can adjust daily management in a most reliable way and also be able to evaluate performance in order to make informed decisions. However in the districts of Arua and Zombo, most the farmers were operating without any form of technical guidance from the extension workers. The farms were poorly sited and have poor investment plan coupled with irregular and improper feeding. In so many cases, farmers were unable to tell whether a profit or losses have been made.

Existing information indicate that farmers lacked complete knowledge about the nutritional requirements for fish yet the aim of feeding fish is to provide the nutritional requirements for good health, optimum growth, optimum yield and minimum waste within reasonable cost so as to optimize profits [8]. In some instances, some farmers didn't even feed their fish because they think fish can grow as long as they are in water.

CONCLUSION AND RECOMMENDATION

The findings of this study indicate that fish farming is an economically viable enterprise in the West Nile Agro-Ecological Zone as evidenced by the positive net returns to investment and gross margins across the districts surveyed. However, aquaculture development among rural households in the region with limited resources remains a challenge. The small scale farmers face many constraints to participate into aquaculture and subsequent adoption of improved technologies and management practices. Among others, the availability of startup capital, availability of feed, quality fingerlings are important in order to adopt, operate and sustain improved fish farming practices and produce quality fish. Since the capital resources to build a commercial hatchery are beyond the means of most local farmers in the region, the government should venture or even encourage other investors into the production of good quality and affordable feeds and fingerlings to reduce on the huge variable costs incurred by farmers. Improvement in economic profitability by changing the existing farming system is more likely to attract formal financial institutions into aquaculture financing in the zone. The problem of feeds can also be addressed by building the capacities of farmers to make cheaper feed formulations from locally available feed materials in order to make them less dependent on the expensive commercial feeds.

This study was necessary and important to be conducted although the sample size was small but this can be explained by the many fish ponds which have been abandoned in the region.

ACKNOWLEDGEMENT

The study was carried out under the Agricultural Technology and Agribusiness Advisory services (ATAAS) project research grant. The authors would like to thank all the District Fisheries Officers of Koboko, Zombo, Arua and Maracha for their support during the study.

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