

Original Research Article

Profitability and Viability Analysis of Aquaculture production in Central Uganda: A case of Urban and Peri-Urban Areas

ABSTRACT

Aquaculture sector if fully exploited has great potential of boosting foreign exchange, household nutritional and incomes levels. However, not much has been done in terms of economic analysis of aquaculture production to attract and guide investment. This study was carried out to assess the profitability and viability of the aquaculture enterprises in central Uganda. The study focused on the socioeconomic and production characteristics, profitability indices and major challenges experienced by the fish farmers. The fish farmers were selected using simple random and purposive method from the farmers' lists provided by the Aquaculture Research Centre. The study was carried out in Kampala, Mukono and Wakiso districts between the months of July and August 2015 using well structured questionnaire complemented with interview schedule. The collected data were analyzed using descriptive statistics and pseudo-profit function. The results indicated that majority (86.8%) of the farms were owned by male aquaculturists. On the average, majority (77.4%) of the respondents' cultured tilapia as the major species. The Tilapia and African Catfish culture periods lasted for 8 and 9 months to attain an average body weight of 0.5kg and 1kg, respectively. The operational costs accounted for US \$ 981 of the total production cost. The Tilapia and African Catfish culture periods lasted for 8 and 9 months to attain an average body weight of 0.5kg and 1kg, respectively. A kilogram of tilapia and catfish were sold at US \$3 and \$2.6, respectively and positive gross margins were reported for both species. A payback period of 3 years and 7 months for tilapia farmers is required to recover initial money invested. The fish farmers still faced challenges of expensive fish feeds, predators and water quality problems due to increasing urbanization. The study recommended the need for farmers to re-organize themselves into cooperatives to collectively purchase inputs, train farmers in business management skills to run aquaculture as sole business entities, stocking of monosex tilapia for easy control of tilapia populations and efficient feed utilization to reduce the current feed conservation ratios.

Keywords: Profitability; viability; Aquaculture production; urban; peri-urban; Uganda

1. INTRODUCTION

The fisheries sector that includes both capture and Aquaculture together contributes 1.2 % to the Uganda's Gross Domestic Product and 5% to the agricultural gross domestic product. The sector generating revenue of about \$134.8 [11], employs about 1.2 million directly and 1.4 million people indirectly along the fish value chain. Despite the fact that natural stocks of

fish and shell fish are renewable, they have limited carrying capacity which cannot be exceeded even under the best management practices, a situation that provides aquaculture with a privilege of being harnessed to bridge the current gap in fish supply [19]. The aquaculture production in Uganda has improved from a tune of 24382.5 in 1995 to 98,063 metric tonnes 2013 [18] via small scale producers, commercial farms and community stocked dams. The current increase in fish production has accelerated the country's contribution from 0.07 percent in 1995 to 0.33 percent in 2014 within the Sub-Saharan Africa [11]. The rise in demand for fish protein sources is attributed to the rise in global population and consistently busier society that demand for healthier animal protein source. Previously, the sector was dominated by traditional extensive culture systems, it is worth to note that pond production areas have improved and there is also increased investment in cage culture [15]. Aquaculture production volumes are expected to increase with the rise in fish prices, stagnating fish supply from capture fisheries, increased investment in cage culture and the current growing demand for food fish [10]. Uganda currently supplies fish and fish products to the neighboring countries particularly Congo, Rwanda and Kenya in form of technical expertise, feed, fingerlings and other aquaculture inputs, which calls for increased investment within the sector. Nile tilapia (*Oreochromis niloticus*) and African catfish (*Clarias gariepinus*) are the commonly cultured fish species. Nile tilapia is the predominant cultivated farmed species among the fish farmers in Uganda due its prolific nature and good taste. However its growth and development has been somehow hampered by uncontrolled reproduction of mixed tilapia in culture system that has resulted into stunting that affects final sizes harvested. African Catfish (*Clarias gariepinus*) production is on the rise and popular among farmers especially in the Eastern region due to perfection in catfish breeding technology even among small scale hatchery operators [13]. The species has got great potential of addressing nutritional security and household incomes, based on the fact that the African Catfish is fast growing, has the ability to thrive on house hold organic waste for its growth [7]. The African catfish has been adopted at different levels of production that include hatchery level for seed production, grow out for table size and some fingerlings sold as baits for exploiting Nile Perch Fishery industry [8]. This particular species is also tolerant to harsh environmental conditions with ability to survive under low dissolved oxygen [7]. The adoption of the commercial quality feeds and increase in stocking rates have seen relatively significant increase in aquaculture production. The above development aspects point to the need for profitability analysis of aquaculture enterprises with the purpose of establishing the feasibility and viability of aquaculture enterprise in Uganda. Economic analysis of aquaculture enterprise has not been fully explored in Uganda apart from two studies of profitability analysis of Aquaculture in central region conducted in the yer region 2011 and socioeconomic valuation of aquaculture 2014 in west Nile [5, 9] to guide aquaculture investment. The inadequacy of information on the economic performance of fish farming in Uganda hampers progress and development of the sector. As a contribution to the decision making during enterprise selection for investment and attracting potential investors within the sector, this study focused on 3 objectives namely: socioeconomic characteristics of aquaculture entrepreneurs, analysis of profitability estimates of the enterprise indices and the major challenges experienced by fish farmers in the peri-urban and urban area of Central Uganda.

2. MATERIALS AND METHODS

The study was conducted in the central Uganda. A multi-stage simple random sampling technique was adopted to draw a sample from the data base list of fish farmers provided by aquaculture research and development center. A total of 53 fish farmers were selected using purposive and snow balling sampling techniques from the three districts of Kampala (6), Wakiso (20) and Mukono (27). These are the districts with a representative number of fish farmers in the central region. In Kampala district, the study covered 3 divisions of Kawempe

(3), Central (1) and Rubaga (2). In Mukono district, the study covered the sub-counties of Naama (4), Goma (9), Kyampisi (3), Nakisunga (4) and Ntenjeru (4) and municipality (3). In Wakiso district, sub counties covered included Wakiso Town Council (5), Nsangi (8), Nabweru (3) and Kakiri (4) fish farmers from all the sub counties and municipalities. A structured questionnaire complemented with interview schedule was used to obtain quantitative and qualitative data needed to explain the phenomena in the way they existed. The collected data were validated using the dropdown list to ensure consistency and check for errors. The collected data were analyzed using descriptive statistic and pseudo-profit function.

An equivalent exchange rate of 3400 Uganda shilling to \$ 1 US [22] was adopted for inputs and output costs involved in fish production in the Central Uganda. Profitability estimate was done based on quantity of fish output in ton. Results were calculated based on the quantities of fish produced in kilogram, investment costs over the production area of 1108M². The collected data were analyzed using descriptive statistic and pseudo-profit function as stated below are the profitability index.

2.1 Pseudo profit function

$$\text{Profitability } (\pi) = T R - T C \quad (1)$$

Where; TR=Total Revenue (US\$); TC=Total cost (US\$); and,

The Total Revenues (TR) were calculated using price (P) multiplied by the quantity of fish harvested (Q)

$$\text{Gross margin } (GM) = T R - TVC \quad (2)$$

Where; TVC=Total variable costs

$$\text{Net farm incomes } (NFI) = GM - TFC \quad (3)$$

Net farm incomes refer to a measure of return to operator's equity that can be distributed among 4 principal factors of production that include land, Labor, capital and management [4]. Where TFC= Total fixed costs. Where fixed costs of these aquaculture enterprises included (ponds construction costs, seine nets, predator nets and water pump) were depreciated using the straight-line method over equipment economic life [3].

$$\text{Depreciation of fixed cost} = \frac{\text{cost of equipments}}{\text{salvage life}} \quad (4)$$

Return on dollar investment (ROI)

$$\text{Return On Investment } (ROI) = GM + TVC \quad (5)$$

GM = gross margin, TVC = total variable cost

Formatted: Highlight

Rate of Return on Capital Invested (RORCI)

$$RORCI = \frac{\text{Net profits before taxes}}{\text{Total production costs}} \times 100 \quad (6)$$

NFI=Net farm incomes, TPC=total production costs

Payback period

$$\text{Payback period (pp)} = \frac{\text{Cost of investment}}{\text{Net cash flow}} \quad (7)$$

This is applicable when dealing with time series data and not cross-sectional data

Formatted: Highlight

Formatted: Highlight

Formatted: Highlight

Gross margin ratio is calculated by dividing gross margins by net sales

$$\text{Gross margin ratio (GMR)} = \frac{\text{Gross margin (GM)}}{\text{Net sales (NS)}} \quad (8)$$

Operating ratio (OR)

$$\text{Operating ratio} = \frac{\text{Total variable costs}}{\text{Gross incomes}} \quad (9)$$

Fixed ratio (FR)

$$\text{Fixed ratio} = \frac{\text{Total fixed costs}}{\text{Gross incomes}} \quad (10)$$

3. RESULTS AND DISCUSSION

3.1.1 Socio-economic characteristics of fish farmers

The study observed that Mukono and Wakiso districts had the **highest biggest** numbers of fish farmers (51%) due to accessibility to reliable water sources and relatively adequate land for expansion, compared to Kampala where farmers are limited by increased urbanization rates that has led to destruction of water supply sources that is limiting aquaculture expansion in urban areas. On the average 88% of the farms were functional, the nonfunctional farms as indicated by the results in (table 1) were taken into consideration to provide insights on the challenges that had pushed the farmers out of business. The study established that 86.8% of the farms visited were owned by men. However the study revealed that both genders (males and females) involved in aquaculture business were still struggling with poor profit margins due to high costs of production. The low levels of women participation in aquaculture production was attributed to limited access to land, high interest rates on agriculture loans that has affected the up scaling of aquaculture production in the central Region. However if men and women are organized under cooperatives under the fish value chain, they can collectively purchase inputs to cut down on production costs. About 46% percent of the farmers had attained tertiary level of education. These farmers had more

than 10 years' experience in aquaculture production, showcasing the importance of aquaculture sector in providing livelihood options to both rural and urban population. 50% of the respondents of age group 40-60 actively engaged in aquaculture production.

Table 1 Socio-economic characteristics of fish farmers

Districts	Percentages	Educational level	Percentages
Mukono	51	Primary	13
Wakiso	38	Certificate	46
Kampala	11	Diploma	4
		Degree	35
		None	2
Gender	Percentage	Farm status	Percentage
male	86.8	Functional	88
Female	13.2	Non functional	10
		under renovation	2
Age	Percentage	Ownership	Percentage
≤39	33.3	Group ownership	8
40-60	52.1	Family	38
61-80	12.5	sole proprietors	55
≥81	2.1		

These are characteristics that define fish farmers in the central region

3.1.2 Production characteristics of aquaculture enterprises

Pond based culture model accounted for 84.9% of aquaculture production in central region. Fish farmers **owned 4 ponds** in Kampala and Mukono districts **owned 4 ponds each**, while farmers **in Wakiso district** owned 3 ponds **each in Wakiso district**. For tank technology, 7.6% **of the** fish farmer **had** adopted concrete tanks for catfish fingerling production and these farmers owned an average of 4 tanks of 1000 liters? **Is the 1000 liters per tank or what?** for grow out fish in Kampala, **challenged with water quality management problems that affects fish growth? Poor linked to the running text**. 57.1% of the farmers practiced monoculture that include the raising of a single species in the production systems, **while and** 42.9% of the farmers cultured fish under polyculture system that included catfish and tilapia. Tilapia (*Oreochromis Niloticus*) emerged as the most cultured species among fish farmers in the central region due to **the** species prolific nature as indicated in (Table 2). 48% of the farmers sourced their seed from Aquaculture Research Centre, 36% from fellow farmers, 4% from farmers' own hatcheries and 12% farmers got their seed from the wild. However, there is need to certify all the seed suppliers in the country and also operationalize regional fry **c**Centers to ensure that farmers are in position to access quality seed to sustain aquaculture production. Spring **waters** (40.4%) **iswere** the major source **of water** for aquaculture production in the three districts, followed by underground water 24.9%, streams accounted for 21.2% and other water sources that included, swamps, rain water supplemented with public National

Formatted: Highlight

water accounted for the remaining percentage. Majority of the farmers (60%) had clean water at source while 34% farmers reported turbid water at source particularly in major towns of Mukono and Kampala. Respondents attributed the poor water quality problems to rise in construction of commercial and residential areas which render the land open with not sufficient vegetation cover to control run-off from rain. ???? Not presented in the Table! The results showed that Fish feeding, 49% of the fish farmers fed their fish on commercial complete diets that included floating, sinking and powdered feeds purchased from local companies like Ugachic, Aquaculture Research and development Centre and other small feed mixers like Nsava Feeds in Mukono district (table 2). Due to high feed costs, 48% of the farmers mixed their own feeds using a combination of locally available feed ingredients like maize bran, cotton seed cake, soya bean, mukene among others to cut-down on the production cost. 11.6% of the farmers fed their fish on plain maize bran and other by-products, supplemented with green vegetables with nutrients required for optimum fish growth. In supplementation with which had negative effects on the final body weight gain. In extreme instances of trying to minimize avoid cost of fish feeding fish, the study found that 7.5% of the farmers did not adequately fed were not feeding their fish.

Formatted: Highlight

Table 2 Production characteristics of Aquaculture enterprises

Seed sources	Percentage	Culture practices	Percentage
ARDC-Kajjansi	48	Monoculture	57.1
Own farm	4	Polyculture	42.9
Fellow farmers	36		
Others	12		
Culture system		Culture species	
Ponds	84.9	Tilapia	77.4
Tanks	7.5	Catfish	18.9
Reservoirs	7.6	Others	3.7
Feed utilization		Feeds suppliers	
Commercial feeds	49	Ugachic	65.4
On farm mixing	31.9	ARDC-Kajjansi	13.5
Maize bran +Vegetables	11.6	Small feed mixers	19

None	7.5
Water sources	
Springs	40.4
Under ground	24.9
Streams	21.2
Others	13.5

3.2: Production cost Analysis for tilapia and catfish enterprises in Central Uganda

Operational costs included seed, feed, labor, organic fertilizers, and lime (table 3). Stocking densities- Farmer stocked 3081 tilapia and 2456 catfish fingerlings in a production area of 1108m². Farmers applied lime in ponds to neutralize acidity before stocking as indicated in the (table 3). 210.1 kg of commercial feeds to feed their fish up to table size. Farmers fertilized their ponds using organic manure to enhance growth of phytoplankton to cut on the feed costs. Regular labor of 1 workers responsible for production and general management of the farm at a cost of US \$59 per month responsible for daily management of the farm. Additional labor of 4 people was hired during harvesting and general farm maintenance. The additional laborers are paid a daily wage of US\$10 per individual depending on the work load (table 3). For general maintenance of the fish farm, assorted tools included hoes, slashers and wheel barrows. Tilapia took an average of 270 days culture period to attain 0.5kg average body weight, African Catfish took an average of 240 days culture period to attain average body weight of 1.5kg. Fixed costs included pond construction, seine nets, predator nets and water pump for the farmers whose ponds could not drain by gravity or easily receive water. Farmers spent f US \$472 to construct a pond size of 1108m² (Table 3), these construction costs are highly influenced by the site location and the type of technology used. Farmers owned an average of 5 predator nets valued at US\$142 for predator control such as birds, otters and snakes. And other farmers were improvising with strings tied around ponds to control predators. The respondents owned one seine net and 1 water pump valued at US\$399 and \$ US356 respectively. Fixed costs of pond construction, seine nets, predator nets and water pumps were depreciated using their salvage life of 5, 2, 4 and 2 years respectively as indicated in (table 3).

Table 3 Investment costs for Tilapia and catfish enterprises crop year.2015

Variable costs	Quantities	Unit cost (US \$)	Total costs (\$)
Fingerlings (Pcs)			
Tilapia	3081	0.06	184.9
Catfish	2455.6	0.09	221.0
Feed (kg)	210.1	1	210.1

Regular labor	1	29.4	265	
Fertilizers (kg)	125.2	0.064	8	
Lime (kg)	107.5	0.25	27	
Additional Labor	4	9.5	38	
Transport costs (feed +seed)		27	27	
Total variable costs (TVC)			981.0	
Fixed costs	Quantities	Unit cost	Total cost (\$)	Depreciated capital
Pond construction (M ²)	1108	2.3	472	94
Seine Nets	1	399	399	199
Predator Nets	5.4	26.2	142	98
Pump	1	356	356	356
Assorted tools	19		55.4	18
Maintenance costs			142	142
Total fixed costs (TFC)			1566.4	907
Total production costs (TVC+TFC)			2547.4	1888.0

All the fixed costs in this table were depreciated using asset value and salvage life. Using an exchange rate of 1US\$ = US\$3400.

3.2.1 Profitability Analysis of tilapia and catfish production

A comparative analysis of profitability was drawn among 15 fish farming enterprises that provided comprehensive input and output data. Operation costs included fingerlings, fish feeds, organic manure, lime and labor constituted a total of US \$ 760 Tilapia and US \$796.1 for catfish enterprises. And the fixed costs included pond construction costs, seine nets and predator nets, assorted tools were depreciated using the equipment salvage value that totaled to 907 as indicated in (table 4). These farmers made sales of 706.1kgs of tilapia and 869kg catfish from monoculture pond production area of 1108m². Revenues generated are based on farm gate prices of US \$ 3 for tilapia and US \$ 2.6 for catfish sold to regional traders and individual consumers within the communities. Positive gross margins were observed for both catfish and tilapia producers (table 4) from unit production area of 1108m² reflecting greater efficiency in turning fish sales into income. A positive gross margins and net farm incomes were highly influenced by quantities of fish marketed and fish prices (table 3). Positive Net farm incomes were observed, a Payback period of 3.7 years and 3.0 years expected for tilapia and catfish recover initial investment costs as indicated in (table 4), and it should be noted that a short payback period is the most desirable. Farmers were expected to produce 555.7kgs of Tilapia and 655kgs of catfish for their enterprises to recoup initial investment costs without making profits neither losses. The study results further indicated at lower quantities of fish (tilapia) produced farmers were expected to sale their fish at relatively higher prices of 2.4 per kilogram of tilapia and 1.9 for catfish farmers to break even. Gross margin ratios were taken into consideration to compare gross margins of the fish farming business to net sale, both enterprises was 0.64%, indicating that the enterprises were in

position to pay for the operating costs. Operating ratios of 0.5 indicated that accompany remained with after paying off the variable production costs, this variable enables enterprises determine their level of efficiency in controlling operational production costs. The fixed ratio for both tilapia and catfish enterprises were 1, an indication that these businesses were operating at breakeven. However it's important for farmers to improve the fixed ratio to above 1 to increase their cash flows which will increase profits significantly

Table 4 Profitability Analysis of tilapia and Catfish enterprises crop year 2015

Parameters	Tilapia US \$*	Catfish US \$*
Yield (kg)	706.1	869
Price/kg	3	2.6
Total Revenues (sales)	2118.3	2259.4
Total variable costs (TVC)	760	796.1
Depreciated capital (TFC)	907	907
Total production costs (TPC)	1,667	1,703
Profitability (TR-TPC)	451	556
Gross Margins (TR-TVC)	1358.3	1463.3
Net farm Incomes (GM- DFC)	451.3	556.3
Return on Investment (GM/TVC)	1.7	1.8
Gross ratio (GMR/Net sales)	0.64	0.64
Operating ratio (TVC/GM)	0.5	0.5
Fixed ratio (TFC/GM)	1.1	1.0
Rate of Return on capital (Net profits/TPC*100)	27.1	32.7
Payback period (cost of investment/net cash flow)	3.7	3.0
Breakeven yield (TPC/Price)	555.7	655
Breakeven price (TPC/Yield)	2.4	1.96

Profitability indices for catfish and tilapia enterprises, All the fixed costs in this table were depreciated to calculate profitability indices for catfish and tilapia enterprises, an exchange rate of 3400 (Ushs) = \$ US 1 was adopted (Bank of Uganda 2016). This result is not empirical as the resource endowments of the respondents vary. The profitability has to be calculated on the basis of per unit output or area of production for each of the species. For the pooled result you should use weighted average and not simple average.

3.3 Major challenges

Expensive fish feeds emerged as the pressing challenge affecting for fish farmers in the central region as indicated in (Figure 1). 23% of the farmers reported predators like oaters, snakes, and birds to be the majorare challenge accounting for contributing to economic losses on the farms. 11 % of the respondents identified inadequate Lack of technical advice during pond construction and general farm management due to limited extension service

provision at district and sub county level [to be the problems affecting them](#). Water quality problems (5.7%) are emerging in the urban and peri-urban areas [where fish are cultivated](#), [these include seasonal drying of ponds, turbidity of water and low water table, a few farmers have constructed water holding reservoirs for desilting and holding water during dry season](#). Other challenges included expensive labor, started fish especially for tilapia at harvest and market competition from wild fish

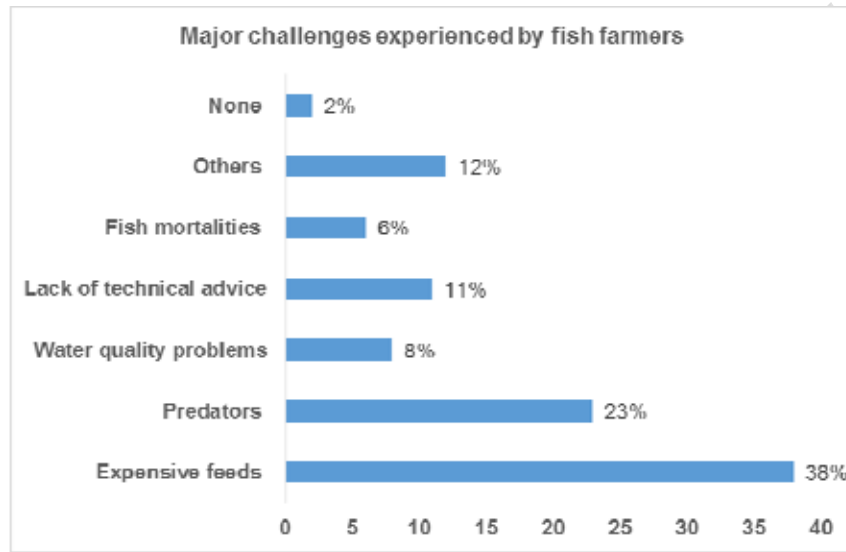


Figure 1. Challenges experienced by fish farmers

4.0 Discussion

Majority of Aquaculture farmers had attained some level of education certificates (table 2), which is advantageous to the sector in terms of quick information dissemination, technology uptake and record keeping. Trailing very close to the farmers with certificate were farmers who had tertiary level of education [1, 16] implying that fish farming is increasingly attracting famers above basic level of formal education. Farmers' high level of education puts them at an advantage of understanding and correctly interpreting agriculture information, share business ideals and network. A few women were actively engaged in aquaculture production (table 2) and much more involved in feeding and harvesting. These disparities could be attributed to the gender roles assigned by our cultures where women have no land ownership right to set up [set up](#) long-term investment [1]. Such disparities have implications on household income, food security because women are [the](#) major determinants of daily household food consumption. The women's role in aquaculture value chain must be fully recognized to streamline their financial independence, empowerment and equality.

Pond based culture model has been widely adopted for fish culture in the central region since majority of the fish farms were constructed between 1994 and 2014. The study observed increase in pond production area to averages of 1108m² in the Central Region as compared to the 200m² pond sizes reported in 2001 [15]. Tilapia was the most cultured species influenced by the local demand and consumer preferences for this particular species. Commercial culture of African Catfish in the central region is affected by cultural, religious beliefs and morphological makeup of this species that makes consumers shy away from catfish consumption. However, it should be noted that this particular species is fast growing, has the ability to forage on any household organic waste and thrive under harse environmental conditions [7]. Therefore there is need tofor training fish farmers on product development and value addition of the African catfish in form of smoked ready to eat products, and fish fillets to increase its consumption. The study noted variations in stocking densities among fish farmers which seemed undefined, and this call fors increased information dissemination for farmers on appropriate stocking densities. Inappropriate stocking densities affected proper fish growth, which prolongs culture period affecting returns on investment inform of extra feeding costs with no significant weight gain [12, 6]. Furthermore, the long culture periods tie down up working capital that could be invested in a more productive way. This also calls for farmers' willingness to switch to faster growing fish strains to obtain better growth within shorter culture period [3] in combination with feeding fish on a quality diet. Operation costs of feed, fingerlings and labor accounted for the biggest percentage of the total production costs as indicated in (table 4) which are similar to the findings reported by [8,16].

Formatted: Highlight

Although aquaculture enterprises can be profitable in short run, their economically viability may not be sustained in the long run. Therefore undertaking input and out-put analysis is important in guiding enterprise selection during investment decision making. A positive gross margin and net income were observed among the tilapia and catfish farmers. Returns on investment were meagre and tilapia had the longest payback period required to recover money invested as compared to catfish (table 4). Relatively low yields were required for tilapia and catfish farmers to breakeven, however it should be noted that farmers do not only need to breakeven in any agriculture business for that particular period of time but also sustainably manage their aquaculture enterprises to recoup all money invested [3]. Farmer profits in this study were highly affected by the high operation costs that included expensive feeds (table 3) which is in agreement with the findings of [5,23]. High cost of feed is a persistent challenge for fish farmers as highlighted by various studies in Uganda (5, 25), Kenya [27] and Nigeria (24, 26 and 24) and can be addressed through research into cheap alternative plant protein sources to replace expensive fish meal. The poor returns on investment observed were a result of small yields due to underutilization of total pond production areas. None the less, appropriate stocking densities, water fertilization and efficient feed utilization are vital for increased fish production. The results are not scientific as such the discussion given above is null and void

Formatted: Highlight

5. CONCLUSION

Aquaculture production in central Uganda is predominately owned by males, who have attained some level of education training. Catfish and tilapia production was profitable and economically viable based on the sample of (15) farmers who provided sufficient data.

Challenges experienced by the farmers included expensive fish feeds, lack of technical advice and water quality management problems that are on the rise in the region, which calls for research on effluent re-use and land saving technologies to sustain aquaculture production in urban and peri urban areas. As the aquaculture industry intensifies, there is need to avail a cheap but efficient feed to the farmers to cut on the current production costs through research on alternative protein sources to replace expensive fish meal, effective information dissemination on specific fish feed management practices to better the current Feed Conversion Ratios (FCRs) per unit fish produced. There is need for government to certify all seed suppliers and extension service providers to deal with the problem of quacks with in the industry, to guarantee quality and protection of fish farmers. Training of farmers in business management skills and record keeping to ensure efficient management of aquaculture enterprises and their portfolios

COMPETING INTERESTS

Authors have declared no competing interests.

REFERENCE

1. Aromolaran, A.B., Analyzing resource use efficiency on fish farms: A case of Abeokuta zone in Ogun State, Nigeria. *Aqua field* 2000: 1: 20–31.
2. Bank of Uganda. Financial stability, 2016: 2079-6293:8, Available www.bou.or.ug
3. Engle, Carole. R. Aquaculture economics and financing: Management and Analysis. [B] Black well publishing 2010: 13:978-0-8138-1301
4. Engle, Carole R. Determining the profitability of an aquaculture Business: Using income statements and Enterprise budgets [B] Regional Aquaculture Centre, University of Arkansas-Pine Bluff. 2012-4402
5. Hyuha, T. S., J.O. Bukenya., J.Twinamasiko, and J. Molnar., 2011. Profitability analysis of small scale aquaculture enterprises in Central Uganda. *International Journal of Fisheries and Aquaculture*, 2011, 2: 271-278.
6. Imani Kapinga, M., E and Kasozi N., Effect of Stocking Density on the Growth Performance of Sex Reversed Male Nile Tilapia (*Oreochromis niloticus*) under Pond Conditions in Tanzania. *World Journal of Fish and Marine Sciences* 2014: 6, 156-161.
7. Isyagi, A. N., Veverica, K. L., Asimwe, R., and Daniels, W. H. Manual for the commercial Pond Production of the African Catfish in Uganda. 2009a: 222.
8. Rutaisire,J., Bwanika, G, Walekhwa P, Kahwa D., Fish Farming as a Business. Fountain Publishers Kampala Uganda 2009: Farm Guide 9, ISBN 978-9970-02-964-8
9. Kasozi N, Degu.I, Opie, H, Ejua, P, Atibuni, K and Mukalazi, J., 2014. Assessment of the Socio-economic value of aquaculture in West-Nile Agro Ecological Zone of Uganda. *World Journal of Fish and Marine Sciences* 2014: 30:245-251.ISSN 2078-4589. Available at 10.5829/idosi.wjffms.

- 385 10. Kifuko R. The state of Cage fish farming in Uganda: Actors Enabling environment
386 challenges and forward International Journal of Education and Research 2015, 3:33
- 387 11. MAAIF/DSIP. Ministry of Agriculture, Animal Industry and Fisheries, Agriculture
388 Sector Strategic Plan 2015/16-2019/20 "Draft. In: Agriculture Report Ministry of
389 Agriculture Animal industry and Fisheries 2016
- 390 12. Muhumuza, M., K. Banks react to Bank of Uganda high lending rates.
391 [http://www.monitor.co.ug/Business/Banks-react-to-Bank-Of-Uganda-high-lending-](http://www.monitor.co.ug/Business/Banks-react-to-Bank-Of-Uganda-high-lending-rate/688322-2790076-12f3xga/index.html)
392 [rate/688322-2790076-12f3xga/index.html](http://www.monitor.co.ug/Business/Banks-react-to-Bank-Of-Uganda-high-lending-rate/688322-2790076-12f3xga/index.html) [Online ed] Uganda Daily Monitor 2015
- 393 13. Mwanja.W. Assessment of fresh water fish seed Resources for sustainable
394 Aquaculture Report, Food and Agriculture Organization of the United Nations 2007:
395 461- 473
- 396 14. NARO/MAAIF Fish farming project Baseline survey. Regional data tables National
397 Agricultural Research Organization (NARO) and Ministry of Agriculture, Animal
398 Industry and Fisheries 2000:
- 399 15. Nyeko, J. I. Over view of fisheries and aquaculture resources, Uganda. Poster
400 presented at the workshop on Fisheries and aquaculture in Southern Africa:
401 Development and Management" Windhoek, 2006:1
- 402 16. Olawumi A.T, Dipeolu A.O and Bamiro O.M. Economic Analysis of Homestead fish
403 production in Ogun State Nigeria Journal Hum Ecol, 2010: 31(1):13-17
- 404 17. Omobepade B.P., Adebayo O.T., Amos T.T. and Adedokun B.C Profitability Analysis
405 of aquaculture in Ekiti State, Nigeria. Nigerian Journal of Agriculture, Food and
406 Environment 2015, 11(1):114-119
- 407 18. Mbowa, S, Odokonyero,T, Munyaho, A.T, Harnessing floating cage technology to
408 increase fish production in Uganda Economic Policy Research Centre-EPRC and
409 National fisheries resources research Institute2017: 138e
- 410 19. Tacon,A.G.J Increasing the contribution of aquaculture for food security and poverty
411 alleviation NACA Bangkok and FAO, Rome 2001
- 412 20. Taylor, C. How to determine whether the Cost-Benefit Ratio is positive or negative
413 The United Nations University 2009.
- 414 21. Uganda Bureau of Statistics (UBOS). National population and housing census 2014
415 main Report Kampala- Uganda.
- 416 22. Uganda Bureau of Statistics (UBOS), the National population and Housing Census
417 Main Report 2016.
- 418 23. Ugumbwa C.O.A and Chukwuji C.O. The Economics of Catfish Production in
419 Anambra State, Nigeria: A profit Function Approach. Journal of Agriculture and Social
420 Sciences 2010, 6:105-109.
- 421 24. Usman, I.S, A.A. Girei and B,I.Tari. "Analysis of the Constraints to the Adoption of
422 Improved Fish Farming Technologies by Farmers in Yola North and South Local

- 423 Government Areas of Adamawa State, Nigeria.” Asian Journal of Agricultural
424 Extension, Economics and Sociology 2016: 10(2):1-6.
- 425 25. Walakira, J., Molnar, JJ, Phelps, R, and Terhune, J. Culturing the African lungfish in
426 Uganda: Effects of exogenous fish feed on growth performance in tanks [J] Uganda
427 Journal of Agricultural Sciences, 2014: 15, 137-155.
- 428 26. Salau E.S, Lawee A.Y,Luka G.E and Bello D. 2014. Adoption of Improved Fisheries
429 Technologies by Fish Farmers in Southern Agricultural Zone of Nasarawa State,
430 Nigeria. Journal of Agricultural Extension and Rural Development 2014: 6(11):339-
431 346.
- 432 27. Munguti M.J, Kim J and Ogello A.E. 2014. An Overview of Kenyan Aquaculture:
433 Current Status, Challenges and Opportunities for Future Development. Fish and
434 Aquatic Sciences 2014: 17(1):1-11.

UNDER PEER REVIEW