Viability and Profitability of Cage Fish Farming on Lake Victoria: A Case of Bugiri-Kiwuulwe Cage Fish Farms in Wakiso District, Uganda

Article *in* Journal of Basic and Applied Research International · October 2024

DOI: 10.56557/jobari/2024/v30i58895

Alex Barakagira
Kyambogo University

Journal of Basic and Applied Research International

Volume 30, Issue 5, Page 29-38, 2024; Article no.JOBARI.12446
ISSN: 2395-3438 (P), ISSN: 2395-3446 (O)

Viability and Profitability of Cage Fish Farming on Lake Victoria: A Case of Bugiri-Kiwuulwe Cage Fish Farms in Wakiso District, Uganda

Samuel Namukonge [a] and Alex Barakagira [a,b*]

[a] School of Sciences, Nkumba University, P.O. Box 273, Entebbe, Uganda.
[b] Faculty of Science, Kyambogo University, P.O. Box 1, Kyambogo, Kampala, Uganda.

Authors' contributions

This work was carried out in collaboration between both authors. Author SN formulated the study objectives, conducted the literature search, designed the methodology, collected the data, and performed the data analysis. Author AB developed the study title and objectives, conducted the literature search, analyzed the data, discussed the findings, and proofread the entire manuscript. Both authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.56557/jobari/2024/v30i58895

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://prh.ikprress.org/review-history/12446

Original Research Article

Received: 02/08/2024
Accepted: 06/10/2024
Published: 15/10/2024

ABSTRACT

Fisheries and aquaculture have crucial contributions to world's wellbeing and prosperity. Among aquaculture practices, cage fish farming ranks highest in fish production. This study was set out to assess viability and profitability of cage fish farming on Lake Victoria, a case of Bugiri-Kiwuulwe cage fish farms in Katabi Town Council, Wakiso District, Uganda. The study sought to assess water quality physico-chemical parameters within and around fish cages, investigates costs of materials used in fish cage fabrications and production, and to find profitability of cage fish farm units. A case

**Corresponding author: E-mail: barakalexham2@gmail.com;*

Cite as: *Namukonge, Samuel, and Alex Barakagira. 2024. "Viability and Profitability of Cage Fish Farming on Lake Victoria: A Case of Bugiri-Kiwuulwe Cage Fish Farms in Wakiso District, Uganda". Journal of Basic and Applied Research International 30 (5):29-38. https://doi.org/10.56557/jobari/2024/v30i58895.*

study design with quantitative and qualitative approaches were employed to obtain data for the stated objectives. A total of 66 respondents from a target population of 79 study participants were used to generate data, which were entered into SPSS version 23 for analysis. Both male and females, including a few youths participated in the study. Their education levels ranged from primary to university. Majority were single, while others were married and a few were widows and widowers. Most of the water parameters tested were in the recommended ranges by WHO and supported aquatic life, hence promoted cage fish farming apart from total hardness, calcium and magnesium hardness, calcium, chemical oxygen demand and potassium which were slightly below the recommended ranges. Majority of the farmers had participated in the business for less than 5 years and the activity brought profits to the farmers an equivalent of UGX 8,943,200 ($ 2,354) to the farmers per season, an indicator that the business venture is very profitable and viable. Hence, it can easily be adopted by members of the community for improvement of their livelihoods. It is recommended that more research be undertaken such that there is formulation of the fish feeds at the local level aimed at the reduction of the higher costs incurred on the imported fish feeds. The government is also encouraged to subsidize on the taxes imposed on implements used in cage fish farming for encouraging more and more farmers to join in the business venture.

Keywords: Cage fish farms; fish production; cage materials; profitability and viability of fish farms; Lake Victoria; Uganda.

1. INTRODUCTION

The global community now faces multiple and interlinked challenges ranging from impacts of ongoing financial and economic crisis to greater climate change vulnerabilities and extreme weather conditions. At the same time, it must meet pressing food and nutrition needs of a growing population with finite natural resources [1]. For five decades, global population growth increased for world fish food, and today fish is an important source of animal protein for the world's population. Fish culture is the world's fastest growing sector in food production, accounting 46.8% of total production in 2016. In addition, fish culture provides income, directly or indirectly to the world's population FAO, [2], but capture fish production is dwindling, while fish production in aquaculture keeps on expanding [3]. Fish is a valuable source of protein and essential micronutrients. Among the 17% of the world population eat fish for animal protein [2]. However, this number can exceed 60% in some countries like Bangladesh [4]. Fish provides animal protein to 3.2 billion people with almost 20% who eat fish for animal protein. Aquaculture provides numerous jobs such as trading in fish and fishing related materials, fish processing, packaging, marketing and distribution, manufacture of fish processing equipment, fabrications of fish cages, net and gear making, ice production and supply, boat construction and maintenance, research and administration. All of the employment, together with dependents, is estimated to support about 10-12 % of the world population [3,5] reported annual individual fish consumption in Africa at average of 10.7 kg and the Near East and North Africa average of 12 kg. Cage fish farming has grown on the shores of Lake Victoria, where Nile tilapia (*Oreochromis niloticus)* is farmed. However, there is little information on its viability.

The decrease in captured of wild fish yields stimulated investment in cage fish culture to lift fish production [6,7]. Capture fish yields, however, has been on a downward trend for decades due to the dwindled wild fish stocks [7]. The increase of human population, causes rise in demand for fish [5,8]. Aquaculture is considered an alternative to the rising demand for fish [9].

Cage fish culture started in 1920, and developed in two countries Kampuchea its origin where fishermen would keep and transport live commercial fish from capture areas to markets in cages made outs of bamboo; and in Indonesia, where bamboo cages were used starting 1922, Gopakumar [10]. The Japanese, further developed cage fish farming, and it rapidly spread to Asia, Europe, United States, USSR, and Africa. Aquaculture in Uganda was dominated by pond culture over years. However, pond-based fish farming has operational constraints that include quick deterioration of water quality, risks like flooding, drying up and or limited land and water. Therefore, more efforts are pointed towards cage fish farming the operationally more efficient system [11,12]. Cage fish farming has potential in water bodies that cannot easily be drained or harvested by seining and are not appropriate for traditional fishing

[13]. Advantages of cage culture include resource use flexibility and maximization; Cage fish farming can be established in a variety of water bodies making it most flexible aquaculture system; Comparably low capital costs, and relatively inexpensive; simplified husbandry practices; fish cages are relatively 'hands-on; simplified operation and with an advantages to partially harvest fish from cages as per need; and multi-use of water resources [14].

Fisheries in Lake Victoria is mainly artisanal moving to commercial production where silver cyprinid *Rastreneobola argentae* (dagaa/ Mukene), tilapia and nile perch account for most of the catch [15,14]. The lake supports food supply, employment and provides income to communities. It supports 30,000,000 individuals of rural communities where 150,000 individuals are employed in the fishery sector Vanderkelen et al., [16] and its annual yield is about 1,000,000 tons [17]. Nile perch was introduced with an intention to reduce the indigenous species and increased fish catch volume hence, changed the system to commercial fishery with export capacity of about 90 per cent in East African countries. For instance, in 2014, about USD 650 million worth believed to have come from Lake Victoria. Fisheries activities in Lake Victoria contribute 2.8% in Uganda, 2.5% in Tanzania, and 0.5% in Kenya to the national GDP, (foreign exchange, revenue, jobs, and food). However, human-oriented activities like farming and over exploitation caused negative effects on the lake affecting its ecosystems. As a result, fish capture declined, biodiversity composition changed and now there is no sustainability of Lake resources on which socioeconomic benefits of local communities depend [15]. Inland fisheries face multiple social and environmental challenges (Hecky et al., 2010; Ogutu-Ohwayo et al., 2016). These contribute to reduced fish catches, decline in fish species diversity and economic value. The catches of preferred food fishes of Lake Victoria declined and the trend is consistent with global decline and stagnation of wild fish production, which is mainly due to exploitation and environmental changes [7]. Capture fisheries production alone can no longer meet both local and international fish demands. For instance, Uganda requires over 600,000 tons of fish per year to raise the national per capita fish consumption to the 21kg recommended by FAO and 400,000 tons to satisfy regional and international markets. If the annual fish production level remained 500,000 tons (400,000 from capture fisheries and 100,000 tons from aquaculture) there will be a deficit of more than 500,000 tons (Ogutu-Ohwayo et al., 2016). Aquaculture is the only viable option to increase fish production to meet the deficit as capture fisheries which cannot be increased any more. By adopting new production systems and technologies of cage fish farming, aquaculture is the fastest growing food industry in the world [18]. Cage fish farming gained momentum worldwide, including the AGL where it started around 2004 on Lake Malawi (Gondwe et al., 2011). Aquaculture activities in Uganda have been growing from small-scale to commercial scale investment [19-21]. The challenges, therefore, have been to develop strong approaches and guidelines, both to secure community wealth and improve strategic factors leading to increased cage fish production. It was therefore important for this study to investigate factors which causes failures of stocking fish in some cages. This study, therefore, investigated quality of the water within and around cages, materials used in cage fishery, input materials' costs, total incomes generated and the profitability of cage fish yields. There is an ongoing multiplication of fish cages while at the same time many are being abandoned, which shows there is likely to be some problems. After assuming so, this study had to investigate the physical, chemical and biochemical factors; cage materials' costs, farms' incomes and their profitability. The study, therefore, was set out to assess viability of rearing fish in cages at Bugiri-Kiwuulwe, Wakiso District, Uganda. To achieve the aim, the study specifically addressed the following objectives: To assess the physico-chemical parameters of water within and around the cage fish farms that encouraged fish farming; To investigate cage designs, sizes and all material inputs used in fish cage fabrications and fish production; and to evaluate and determine the profitability of the cage fish farming in the study area.

2. METHODOLOGY

The study was carried out at Bugiri-Kiwuulwe in Katabi Town Council, Wakiso District, Uganda. A case study design was adopted and it was complemented with quantitative and qualitative approaches of data collection. This approach was used to collect variety of data and revealed discrepancies which a single technique would not give, hence it gave reliable information. Qualitative design helped to give detailed information while quantitative design involved the collection of numerical data.

The study used a sample of 66 respondents drawn from target population of 79 study participants determined using Yamane's formula; n=N/1+Ne^2. All 66 respondents who actively participated in the study included 12 farm owners, 12 farm managers, 18 workers, 16 fish traders and 8 local leaders were purposively selected because, the researcher needed knowledgeable people in relation to cage farming. Using the questionnaire and observations, data were collected and information about fish cage farm practices and benefits were generated. The questionnaire consisted of the closed ended questions which were designed based on a five Likert rating. Also, data were collected using face-to-face interviews. For water quality parameters, water samples were collected in clean plastic bottles and placed in a cool box. The samples were then taken to the water laboratory at Entebbe, Ministry of Energy and Minerals Development for analysis. In some cases, a multiparameter water testing kit was use to measure some parameters in-situ. These included pH, temperature, and turbidity. The material inputs for cage construction were computed using the current market value. All the expenses incurred and the incomes obtained during the fish production in cages were considered in determining the profitability and viability of the business activity.

Primary Data was generated from respondents in Bugiri-Kiwuulwe while Secondary data was obtained from fisheries reports, published and non-published research, technical reports, scientific journals, FAO database and prominent cage fish farms. The collected quantitative data were coded, cleaned and entered into an SPSS version 24 for analysis. Data from respondents was checked for accuracy before coding and then was subjected to content analysis. Responses from open-ended questionnaires were also included. In interpreting results, issues that appeared with high frequencies were interpreted as a measure of importance. Qualitative data was arranged into themes based on the study variables. Data were presented in percentages, and also in the monetary values to revel the profitability. Qualitative data were presented in words following the themes spelt out in the interview guide.

3. RESULTS AND DISCUSSION

3.1 Demographic Information

The study covered the demographic characteristics of the respondents and the results are as shown in the following figures.

Fig. 1 shows that two-thirds of the respondents (68%) were male while only a third (30%) were female. Although the majority were males, both genders participated or had an idea of cage fish farming in the study area. Slightly less than two-thirds (64%) of the respondents were aged between 18-45 years, signifying that, the activity was involved in by the middle-aged individuals who had capacity to source some funds to finance the projects as shown in Fig. 2.

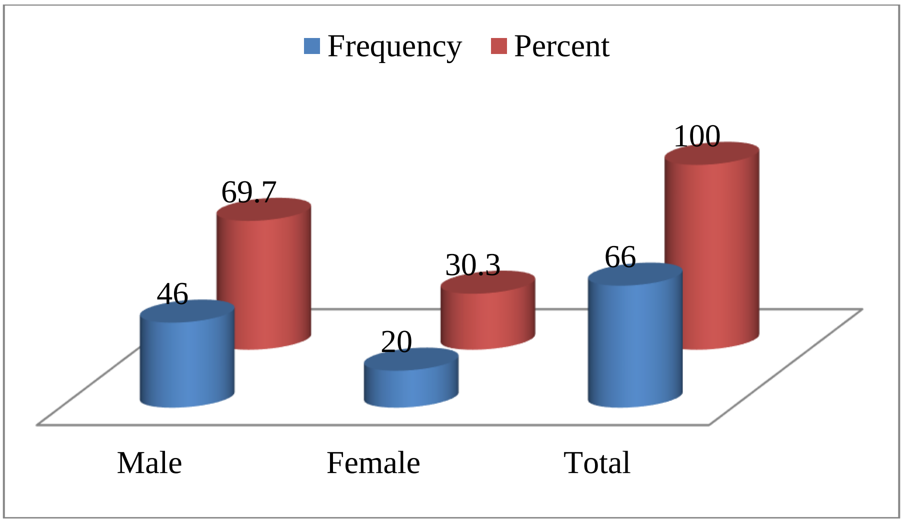

Fig. 1. Gender of the Respondents
(Source: Field Data, 2024)

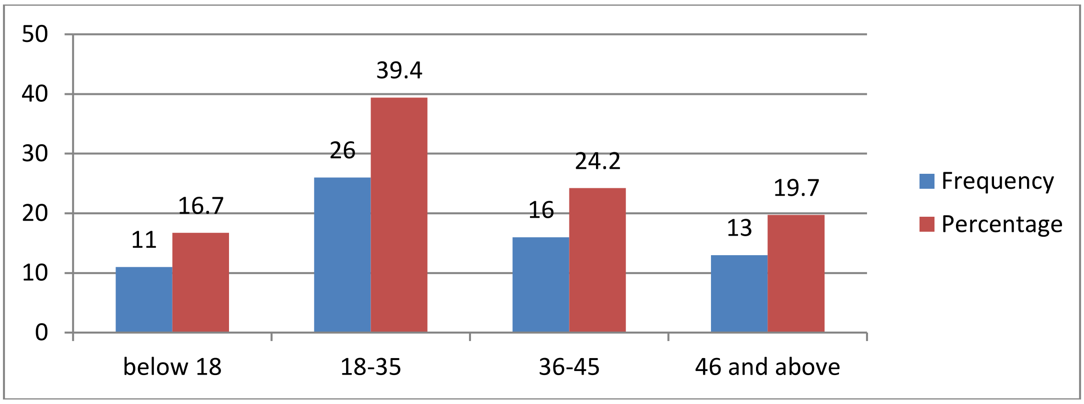

Fig. 2. Age bracket of the Respondents
(*Source: Field Data, 2024)*

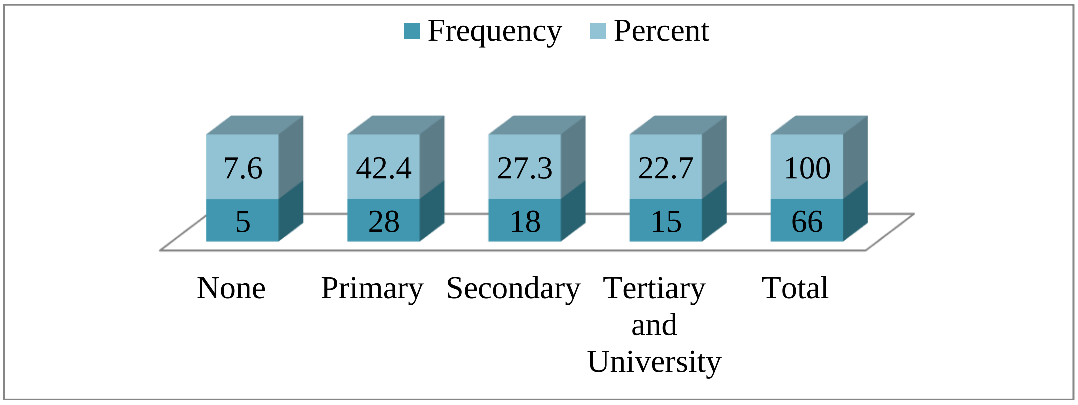

Fig. 3. Education Level of the Respondent
(*Source: Field Data, 2024)*

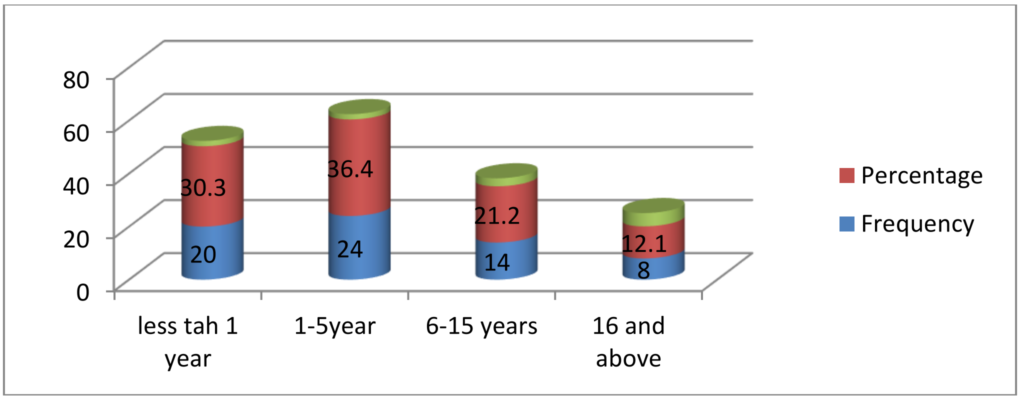

Fig. 4. Period in cage fish production
(Source: field data (2024)

One-half of the respondents (50%) had level of education of secondary and above as shown in Fig. 3, signifying that, for the activity of cage fish farming, an individual was supposed to be knowledgeable enough about the processes of cage fish farming for it to flourish. In addition, having some higher qualification enabled the individuals to seek for some official jobs for extra income that supported the projects since they required substantial amounts of money as will be observed later.

One-third of the respondents (33%) had participated in the activity of fish farming for a period of six years and above as shown in Fig. 4. This is an indicator that the business activity was likely to be viable and profitable as about 45% of the respondents earned UGX 8,943,200 ($2,354) per season, as shown in Fig. 5, when participating in the business venture.

3.2 Physico-Chemical Parameters of the Water where Cages are Situated

The physico-chemical parameters of the water from where cage fish farming is taking place were determined both in-situ and in the laboratory. Water samples from two different points at depths of 0.5m from the Lake surface and at 0.5m above the lake bottom where the ponds were located were collected in clean plastic laboratory bottles using a computerized multi-parameter probe machine and analyzed. The results are as shown in Table 1.

From Table 1, all the water parameters that were tested, including but not limited to pH, Electrical Conductivity, Total Dissolved Solids, Total hardness, Nitrates, Phosphates, COD were all within the permissible levels as recommended by the WHO. It was only the Mg concentration and BOD that were above the permissible levels. This was probably brought about by the fish feeds that contained more of the Mg containing substances. The higher BOD was probably as a result of some micro-organisms that were breaking down the nutrients present in the fish feeds.

The results are in agreement with authors like Tacon [18] and Sitoki et al. [17] who stated that the presence of the micro-organisms breaking down the food substances in the water environment may compromise the quality of the water environment which may lead to low yields in fish grown in cages. Mishu & Rashmi [22] states that good water physical parameters promote fish farming as the conditions will be very favourable for fish growth. Such fish growths are likely to result into good yields which at the same time may improve the livelihoods of the people who practice fish farming [23-26] Some authors state that water quality in fish farming influences feeding, growth, disease burdens, and survival rates [10]. In addition, water quality is affected by many factors, including weather conditions. For example, Dissolved Oxygen (DO) is related to phytoplankton production and respiration; nitrogen waste like ammonia is related to the amount of organic matter inputs and ammonium excretion by fish; and, water temperature and thermal stratification are controlled by sunlight and air temperature [27]. Aura et al. [11] reports that poor water quality is the cause of problems. Fish may not eat aggressively due to stress from high ammonia levels, nitrite toxicity, low dissolved oxygen, high levels of carbon dioxide, and other water quality problems. Therefore, since most of the conditions within the fish cages were within the permissible levels, they encourage fish growth.

3.3 Viability and Profitability of the Cage Fish Farming

To determine the viability and profitability of the cage fish farming, material inputs were determined together with the sales at the end of the season. Cage frames are of different sizes made out of round Iron or plastic pipes either in a square, rectangular or round shape. Round Iron pipes are more common than square and rectangular fish cages. Plastic round pipes are always used in fabrication of round cages. Wire mesh is used to make iron cage covers to prevent predators and thieves. Cage covers are made out of either a plastic net mesh or wire mesh with a lockable hatch on top. The cage cover guards fish inside the cage against predatory birds and thieves who would pick fish from top of the cage. Anchors are heavy mooring blocks made out of concrete or metal for securing cages in one position. Anchors hold cages in position and do not allow strong winds to carry them away from the point of anchorage. Sinkers are employed at the bottom of the cage at different points and comers of the cage to keep them stretched in position and not to allow the bag to coil or to be twisted inside or on side which minimizing the required space for fish. The average material inputs during fish production are as shown in Table 2.

The profitability calculation is as follows:

Average total life span of a cage at Bugiri - Kiwuulwe is 15 years.

Depreciation Cost per year = Total Cost of Cage, boat &Engine / Total life period = 19,926,000 / 15 =1,328,400/-

The Total costs per year = Total operating costs + depreciation = 33,200,000 + 1,328,400 = 34,528,400/-

Total Revenue (TR) = yield x price

8000 fish was harvested at average of 0.7 kgs and sold at 8000/- per kg.

Therefore, Total Revenue = 8000 x0.7kgs x 8000 = 5600 x 8000 = 44,800,000/-

Total Operating Cost (TOC) = TVC + depreciation =33,200,000+1,328,400/-OPC = 34,528,400/-

Gross margin = TR - TOC

Gross Margin (GM) = 44,800,000– 34528400 = 10,271,600/-

Net farm income (NFI) = GM – Depreciation = 10,271,600 - 1,328,400/ = Average Net Income = 8,943,200/= ($ 2,354)

The average net income of farmers undertaking cage fish farming is UGX 8,943,200 ($ 2,354) per season. Since there is a big likelihood of farmers getting profits from the business venture, its viability is also regarded as high and it motivates farmers to continuously undertake the activity, which eventually improves their livelihoods. In line with some authors like Ertan [28] and Daud [29], they posit that, when the material inputs and the operating costs of venturing into fish farming are cost friendly, the business owners are highly encouraged to continue practicing fish farming.

Table 1. Physico-chemical parameters of the water (Primary data, 2024)

Parameter	Units	0.5m Below L. Surface	0.5m above L. Bottom	Recommended by WHO
Color (Apparent)	PtCo	44	51	1
Turbidity	NTU	26	19	< 30
pH	pH units	7	7	6.5 – 9
Temperature	^0C	27^0C	26^0C	27 – 31
Electrical conductivity	pS/cm	54	53	84
Total dissolved solids	mg/L	38	38	<1500
Total hardness as CaCO3,	mg/L	24	22	< 120 – 170
Calcium hardness as CaCO3,	Ppm mg/L	14	11	150 -400
Magnesium hardness as CaCO3	mg/L	10	10	x 0.243
Calcium	mg/L	6	5	8.8 – 10.4
Magnesium	mg/L	2	2	>125
Sodium	mg/L	3.5	3.2	< 2300
Potassium	mg/L	0.8	0.8	3.5 - 5.5
Total Alkalinity	mg/L	27	28	80 – 200
Bicarbonates	mg/L	32	34	5.3
Sulphates	mg/L	<0.3	<0.3	< 250
Chlorides	mg/L	3.4	3.4	< 250
Nitrates as N	mg/L	0.15	0.14	< 45
Nitrites as N	mg/L	0.00	0.00	<1.0
Ammonium as N	mg/L	0.003	0.002	< 3
Phosphates as P	mg/L	0.25	0.09	2.8 – 4.5
Silica	mg/L	21	20	< 30
Chemical Oxygen Demand	mg/L	5	10	50 – 4000
Oxygen	mg/L	78	68	75 – 100
BOD	mg/L	82	78	80

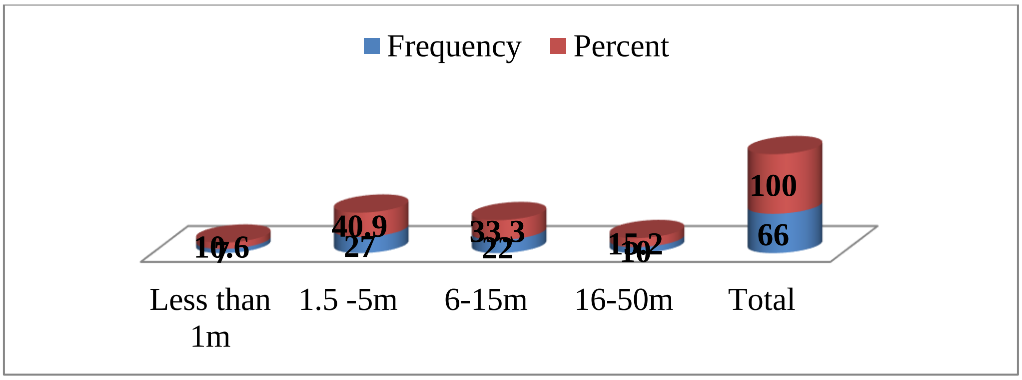

Fig. 5. Average Annual Income
(Source: field data (2024)

Table 2. Average material inputs during fish production using 6X6X6 cage (Primary data, 2024)

S/N	Materials	Quantity	Average Unit Price	Amount (UGX)
	Average Operating Costs			
1	Fish seed	8000 fish	@ 200/-	1,600,000
2	Fish feed	5200 kgs	@ 4000/-	20,800,000
3	Fuel	12 months	180,000/-	2,160,000
4	Security	12 months	300,000/-	3,600,000
5	labour	12months	320,000/-	3,840,000
6	Rent	12 months	100,000/-	1,200.00
	Sub-Total			**33,200,000**
	Average Fixed Costs (Cage, Boat and Engine)			
7	Plastic drums	12	90,000	1,080,000
8	Round iron pipes	8	72,000	576,000
9	Net bag	2	2,500,000	5,000,000
10	Anchors	2	150,000	300,000
11	Ropes	1Role-45mm	500,000	
12		1 Role - 8mm	100,000	600,000
13	Sinkers	5	6,000	30,000
14	Bolts & nuts	3 boxes	8000	240,000
15	Fabrication		1,800,000	1,800,000
16	Boat	1	1,300,000	1,300,000
17	Engine	1	9,000,000	9,000,000
	Sub-Total			**19,926,000**
	Grand Total			**53,126,000**

Note: UGX 3800 = $ 1

4. CONCLUSIONS AND RECOMMENDATIONS

Most of the water parameters in and around the fish cages were within the recommended standards, favourable for the growth of fish. In addition, the study revealed some significant profits from undertaking the cage fish farming, showing that the business is very viable and that could contribute to a good livelihood to the members of the community and the country at large.

However, it is recommended that fish farmers try to formulate their fish feeds in order to lower the production costs for bigger profits since the higher costs on the feeds greatly impacted on the farmer's income. The government is also encouraged to subsidize the taxes on the imported materials used in fish farming for further encouragement of many more farmers to join the fish farming business venture.

5. SUGGESTED FURTHER RESEARCH

Similar research studies should be undertaken in other parts of Lake Victoria to determine the viability of cage fish farming within the East African region. In addition, more research should be undertaken on the formulation of locally made fish feeds so that farmers can easily access cheaper feeds such that they can be more motivated to undertake the business of fish farming.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

ACKNOWLEDGEMENTS

We thank all our respondents and the Officials from Fisheries Training Institute, who participated in the study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. FAO. The State of World Fisheries and Aquaculture Rome. 2012;209.

Available:www.fao.org/docrep/016/i2727e/i2727e00.htm).

2. FAO. The State of World Fisheries and Aquaculture 2018 – Meeting the Sustainable Development Goals. Rome. Licence: CC BY-NC-SA 3.0 IGO.
3. FAO. The State of world fisheries and aquaculture. Opportunities and Challenges. FAO Fisheries and Aquaculture Department, Rome; 2014.
4. Baqui MA, Bhujel RC. A hands on training helped proliferation of Tilapia culture in Bangladesh; 2015.
5. FAO. The State of world fisheries and aquaculture: Contributing to food security and nutrition for all. Rome, Italy. FAO. 2016;200.
6. Kashindye BB, Nsinda P, Kayanda R, Ngupula GW, Mashafi CA, Ezekel CN. Environmental impacts of cage culture in Lake Victoria; the case study of Shirati Bay-Sota Tanzania; 2015.
7. Njiru JM, Aura CM, Okechi JK. Cage fish culture in Lake Victoria: A boon or a disaster in waiting? Fisheries Management and Ecology. 2019;26(5):426 – 434.
8. FAO. The state of world fisheries and aquaculture: Sustainability in action. 2020;32(6). Rome, Italy:
9. Araki H, Barry A, Berejikian M, Ford J, Blouin MS. Hatchery Stocking for restoring wild populations a genetic evaluation of the reproductive success of hatchery fish vs. wild fish. Fisheries for Global welfare and environment 5th world Congress; 2008.
10. Gopakumar G. History of cage culture, cage culture operations, advantages and disadvantages of cages and current global status of cage farming. Cage Culture of Seabass. 2009;1(6):8–12.
11. Aura CM, Musa S, Yongo E, Okechi JK, Njiru JM, Ogari Z, Wanyama R, Charo Karisa H, Mbugua H, Kidera S. Integration of mapping and socio economic status of cage fish farming: Towards balancing lake use and culture fisheries in Lake Victoria, Kenya. Aquaculture Research. 2018;49(1): 532-545.
    Available:https://doi.org/10.1111/are.13484
12. Orina PS, Ogello E, Kembenya E, Githukia C, Musa S, Ombwa V, Mwainge VM, Abwao J, Ondiba RN, Okechi JK. State of cage culture in Lake Victoria, Kenya. Kenya Marine and Fisheries Research Institute (KMFRI); 2018.
    Available:https://repository.maseno.ac.ke/handle/123456789/2258
13. Degefu F, Mengistu S, Schagerl M. influence of fish cage farming on water quality and plankton in fish ponds a case study in the Rift Valley and North Shoa, reserves, Ethiopia; 2011.
14. Luomba J. A bottom –up understanding of illegal unreported and unregulated fishing in Lake Victoria. Uganda; 2016.
15. Nyamweya CSE, Sturludottir T, Tomasson A, Taabu-Munyaho JM, Njiru, Stefansson G. Lake Victoria Overview of Research needs and the way forward. Kampala, Uganda; 2020.
16. Vanderkelen Inne, Van Lipzig Nicole PM, Wim T. Modeling the water balance of Lake Victoria (East Africa) Part 1; Observational analysis. East Africa; 2018.
17. Sitoki LM, Guchuki Ezekiel C, Wanda, Mkumbo OC, Mashall BE. The Environment of Lake Victoria (East Africa): Current Status and Historical Changes; 2010.
18. Tacon AGJ. Increasing the Contribution of Aquaculture for Food Security and Poverty Alleviation. In: Subasinghe RP, Bueno P, Phillips MJ, Hough C, McGladdery SE, Arthur JE. (Eds.) NACA/FAO, Aquaculture in the Third Millennium. Technical Proceedings; 2001.
19. Karaduman T. Synthesis, investigation of biological effects and in silico studies of new benzimidazole derivatives as aroatase inhibitors; 2020.
20. Musinguzi L, Lugya J, Rwezawula P, Kamya A, Nuwahereza C, Hlafo J, Kamondo S, Njaya F, Aura C, Shoko AP. The extent of cage aquaculture, adherence best practices and reflections for Sustainable Aquaculture on African Inland Waters; 2019.
21. Chulha W, Ojwala J. are we really out of Chulha Trap. A case study from a district of Mahasrashtra; 2018.
22. Mishu S, Rashmi Y. Physico–chemical parameter for water quality check: A Comprehensive Review; 2018.
23. Barakagira A, Kateyo E. Impacts of wetland drainage on domestic water supplies and people’s livelihoods in Kabale district, Uganda. 12th Biennial Conference of the International Association for the Study of Commons, University of Gloucestershire, UK; 2006.
    Available:http://iasc2008. glos. ac. uk/conference% 20papers/papers/B

24. Barakagira A, de Wit A. (Community livelihood activities as key determinants for community-based conservation of wetlands in Uganda. Environmental and Socio-economic Studies. 2017;5(1):11–24. Available:https://doi.org/10.1515/environ-2017-0002
25. Barakagira A, de Wit A. The role of wetland management agencies within the local community in the conservation of wetlands in Uganda. Environmental and Socio-economic Studies. 2019;7(1):59-74. Available:https://doi.org/10.2478/environ-2019-006
26. Baguma, C. & Barakagira, A. Effects of wetland drainage on community livelihoods: A case of Mabengere wetland in Kisita sub-County, Kakumiro district, Uganda. Journal of Global Ecology and Environment. 2023;19(1):1-9. Available:https://doi.org/10.56557/JOGEE/2023/v19i18396
27. Sriyasak R. Effects of temperature upon water turnover in fish ponds in Northern Thailand. Thailand; 2015.
28. Ertan, Effects of Different Postharvest Storage Methods on the Quality Parameters of Chestnuts (*Castanea sativa* Mill); 2015.
29. Daud P. Effects of feeding frequency on growth performance, feed utilization and body composition of Juvenile Nile Tilapia *Oreochromis niloticus* (L) Reared in Low Salinity Water; 2016.

Peer-review history:
The peer review history for this paper can be accessed here:
https://prh.ikprress.org/review-history/12446