African Journal of Agriculture and Utilization of Natural Resources for Sustainable Development (AJAUSUD) November, 2024

ISSN 2313-1306
Available Online at www.ajausud.apiiis.com

Exploration of the Status of Fish Farming Enterprises among Farming Communities in Nyandarua, Nakuru, and Nyeri Counties of Kenya

Omasaki, Simion [1*] and Kiplangat, Ngeno [2]

[1*]Animal Breeding and Genomics Group, Department of Animal Sciences, Kisii University, P. O. Box 408, 40200 Kisii, Kenya

Email Address: skomasaki@kisiiuniversity.ac.ke

[2]Animal Breeding and Genomics Group, Department of Agriculture, Animal Sciences and Natural Resources, Moi University, P. O. Box 3900 - 30100,Kesses, Eldoret, Kenya

Email Address: aarapngeno@kisiiuniversity.ac.ke[2]

Corresponding author: skomasaki@kisiiuniversity.ac.ke[1*]

Corresponding author: skomasaki@kisiiuniversity.ac.ke[1*]

Abstract

Understanding the status of fish enterprises is vital for developing policies to enhance their productivity and economic growth. This study assessed the status of enterprises raising three main farmed fish species: Nile tilapia (*Oreochromis niloticus*), African catfish (*Clarias gariepinus*), and rainbow trout (*Oncorhynchus mykiss*), among farming communities in Nyandarua, Nakuru, and Nyeri counties in Kenya. The study selected these Kenya Climate Smart Agricultural Project (KCSAP) priority counties because these regions offer ideal conditions for fish farming and they represent promising areas for developing climate-smart fish farming. Using a snowball sampling procedure, the study identified 34 fish farms. Descriptive analysis was employed to examine socio-economic factors, production objectives, rearing methods, labour, markets, and marketing practices. Results showed that farmers aged 30-49 were most engaged in fish farming (23.5%). Family and family-hired labour were the most common sources. The majority (81.2%) of fish farmers preferred male labourers. Over 71.9% practiced commercial fish farming, primarily to generate income, and most emphasized producing table-size fish. The rearing period for tilapia, catfish, and trout fish were approximately 10.4, 10.2, and 12 months, respectively, with harvested average weights of 326.76 grams, 1357.14 grams, and 555 grams, respectively. Nile tilapia farmers mostly produced table-size fish, unlike trout and catfish farmers who targeted fingerlings, brooders, table-size fish, and fillet production. Prices for fingerlings, raw, and processed (value-added) fish ranged from 9.7 to 28 Kenyan shillings (KES), 335 to 650 KES, and 700 to 1200 KES, respectively. Farmers sold mature table-size fish at average prices of 335 KES, 540 KES, and 650 KES for tilapia, catfish, and trout, respectively. The price for value-added tilapia, catfish, and trout were 700 KES, 700 KES, and 1200 KES in that order. In conclusion, fish farming in Nyandarua, Nakuru, and Nyeri counties generates cash income, creates employment opportunities, ensures food and nutrition security, and contributes to societal empowerment for these communities.

***Keywords**:* African catfish, enterprises, Nile tilapia, rainbow trout, Kenya

Corresponding author: skomasaki@kisiiuniversity.ac.ke[1*]

Introduction

Aquaculture farming is currently the world's fastest-growing animal food producing sector, with an average annual growth rate of 8.6% (FAO, 2014, 2018). It provides livelihoods for many people and is a good alternative source of income for rural communities (World Bank, 2013). Fisheries and aquaculture are a vital source of essential nutrients, supporting the livelihoods of 10-12% of the world's population and accounting for over 17% of globally consumed animal protein (FAO, 2014, 2018). Africa has enormous potential for aquaculture expansion, but currently contributes only 2% of total global aquaculture production (FAO, 2020). Egypt is a major African producer, while Sub-Saharan Africa contributes only 0.6% (FAO, 2014, 2018). Smallholder aquaculture production accounts for 95% of the total, with Nile tilapia farming contributing 40% (Omasaki et al., 2016). In Kenya, aquaculture is practiced by small-scale farmers using semi-intensive earthen ponds. This system is characterized by low inputs and diverse farming conditions in terms of income level and market objectives (Omasaki et al., 2016). The main farmed fish species include Nile tilapia (*Oreochromis niloticus*), common carp (*Cyprinus carpio*), African catfish (*Clarias gariepinus*), and rainbow trout (*Oncorhynchus mykiss*) (Opiyo et al., 2017). Aquaculture farming has increased steadily in Kenya since the government's national fish farming enterprise productivity program launched in 2009. The program provided farm subsidies, established new hatcheries, and revived and expanded existing ones. Consequently, the number of fish farmers increased dramatically, from 4,742 to 49,050 (Nyandat & Owiti, 2013). Land dedicated to aquaculture farming expanded from 722 hectares in 2008 to 3,500 hectares in 2018 (Opiyo et al., 2018). Production levels also increased significantly, from 4,452 metric tonnes in 2008 to 24,096 metric tonnes in 2014. In 2020, fish outputs increased by 7.6%, from 18.5 thousand tonnes in 2019 to 19.9 thousand tonnes. Currently, fish farming contributes 16.1% to the total fish production in Kenya (Economic Survey, 2021). Fish farming has emerged as a significant contributor to food security, income generation, and rural development in several regions in Kenya. While studies have documented the status of fish farming around Lake Victoria and the western regions, information on the sector in the Mount Kenya region remains limited. This lack of data

Corresponding author: skomasaki@kisiiuniversity.ac.ke[1*]

hinders effective planning, resource allocation, and the development of targeted support programs for fish farmers in this area. Therefore, this study aimed to address this gap by assessing and documenting the status of fish farming among fish farming communities in Nyandarua, Nakuru, and Nyeri counties within the Mount Kenya region.

Materials and Methods

Study area

This study was conducted in three priority counties for the Kenya Climate Smart Agricultural Project (KCSAP) in Kenya: Nyandarua, Nakuru, and Nyeri. A total of nine sub-counties and 14 wards were sampled (Table 1).

Table 1: Sampled Kenya Climate Smart Agricultural Program (KCSAP) priority counties, sub-counties and wards

County	Sub-counties	Wards
Nakuru	Gilgil	Gilgil
	Naivasha	Hells gate, Maeilla
	Nakuru Town East	Menengai
	Kinangop	Gathara, Githioro, North kinangop
Nyandarua	Kipipiri	Kipipiri
	Ndaragwa	Kiriita, Shamata
	Oljoroorok	Weru
	Olkalou	Rurii
Nyeri	Kieni East	Kabaru, Naromoru

Survey design

The study employed a snowball sampling procedure, involving a total of 34 fish farms (Table 2). KCSAP county coordinators and county livestock officers identified the initial participants in the sampling process. Through snowball sampling, these initial farmers then identified other fish farmers in their network. To be included in the study, farmers had to meet the defined criteria of raising fish species like tilapia, catfish, or trout. Baseline information was collected from fish farmers using a pre-tested, semi-structured questionnaire loaded onto Open Data Kit (ODK) software. This questionnaire covered socio-economic characteristics, production systems, rearing practices, labour, markets, and marketing practices. The data collected from farmers was entered and analyzed using the Statistical Package for Social Sciences (SPSS) version 20. Descriptive statistics such as means, relative frequencies, and percentages were employed to achieve the study's objectives.

Corresponding author: skomasaki@kisiiuniversity.ac.ke[1*]

Results and discussion

Socio-economic characteristics of fish farmers

Among the respondents, the gender distribution was 71% male and 29% female. Their educational backgrounds were primarily post-secondary (38.2%) and secondary education (26.5%). The majority of the fish farmers (47.1%) owned their land, while 23.5% farmed on family-owned land. Table 2 presents the age distribution of fish farmers in the study area. Farmers in the 30-49 age brackets were the most engaged in fish farming (23.5%), which aligns with the prime working age range for humans. Conversely, participation was lowest among respondents in the 20-29 and 50-59 age groups. This finding suggests that despite the high returns associated with fish farming and the significant youth unemployment rate (over 7.27% for 18-35 year olds in Kenya as of 2020) (ILO, 2020), few young people are actively involved. Our data shows that a majority (58.6%) of the farmers in the study area are older (between 40 and 60 years or above), compared to only 40% who aged 20-39 are. These results support the United Nations Development Program's (UNDP, 2011) observation that Kenya's agricultural sector is experiencing an aging population due to a lack of appeal among younger generations. Consequently, there's a need to train and educate young people about the potential of fish farming for job creation.

Table 2: Age structure of the respondents in the three study counties

Age group	Frequency	Percent
20-29	6	17.6
30-39	8	23.5
40-49	8	23.5
50-59	5	14.7
>60	7	20.6
Total	34	100.0

Labour preference

Family labour most common in fish farms

Table 3 details the sources of fish farm labour and gender preferences across the studied counties. Family labour is the dominant source (31.3%), followed by hired labour (25%) and a combination of family and hired labour (25%). Communal and group labours are the least preferred options. Financial constraints are a key reason for the prevalence of family labour, as many fish farmers lack the capital to hire external workers. Family members offer a readily available and potentially lower-cost

Corresponding author: skomasaki@kisiiuniversity.ac.ke[1*]

alternative. Additionally, fish farming requires close attention and coordination, and using trusted family members can facilitate better communication and pond management, especially for smaller farms with limited resources.

Gender disparity in fish farming

Gender plays a significant role in aquaculture. Females comprise only 18.8% of the workforce compared to 81.3% males (Table 3). The preference for male labourers stems from a combination of factors. Traditional gender roles often associate physically demanding tasks with men, and fish farming involves activities like pond construction, hauling nets, and handling heavy equipment. Limited access to education and technical training for women in these regions further disadvantages them for these perceived strenuous roles. Cultural norms might also influence the perception of aquaculture as a male domain, discouraging women's participation. This creates a cycle where the lack of female involvement reinforces the idea that fish farming is unsuitable for women, potentially hindering its adoption by younger women and women in general.

Breaking down barriers for women in aquaculture

While the importance of women's inclusion and gender equality in fish farming is increasingly recognized, their roles are still limited by low literacy levels and inadequate technical knowledge on pond management. These challenges are not unique to this study and are faced by women in aquaculture globally, across various segments of the value chain (Butt et al., 2010; Ndanga et al., 2013). To address this imbalance, specific efforts are needed to increase women's participation in training programs, improving their understanding of fish farming practices. Furthermore, having more female extension agents could be beneficial, helping to overcome cultural barriers and encourage more women to pursue careers in fish farming (FAO, 2014). Ultimately, by promoting women's involvement in aquaculture production and various fish farming activities, the sector can achieve its full potential for enhanced productivity.

Corresponding author: skomasaki@kisiiuniversity.ac.ke[1*]

Table 3: Source of labour and gender preference of labourers across the three counties

Source of labour	Frequency	Percent
Family	10	31.3
Hired	8	25.0
Communal	2	6.3
Others	2	6.3
Family and hired	8	25.0
Group members	2	6.3
Total	***32***	***100***
Gender preference of labourers		
Male	26	81.2
Female	6	18.8
Total	***32***	***100***

Fish Species and Production objectives

Table 4 details the purposes (commercial, subsistence, and others) and specific commercial goals (table size, fillet, fingerling, or brood stock production) for different fish species raised by the farmers. The majority (71.9%) engage in commercial fish farming, primarily for income generation. Nile tilapia farmers predominantly produce table-size fish (14%), while trout and catfish producers have more diverse goals, including fingerling, brood stock, table-size, and fillet production. Across all surveyed households, the commercial focus varied depending on the fish species. The weight of fish at harvest is a significant factor for both fish producers and consumers (Blonk et al., 2010; Trọng et al., 2013). Most farmers prioritize producing table-size fish. Heavier fish at harvest command higher market prices, explaining the preference for this size category. A smaller number of farmers focus on fingerling production. Our observations suggest that this group may have a higher level of knowledge and resource endowment. Sevilleja (2001) supports this notion, reporting that fingerling production and management generally require more resources, skills, and technology compared to rearing fish to grow-out size.

Corresponding author: skomasaki@kisiiuniversity.ac.ke[1*]

Table 4: Purpose and commercial purpose of Tilapia, catfish and trout fish species farmed

Purpose of rearing	Frequency	Percent
Commercial	23	71.9
Subsistence	1	3.1
Others	1	3.1
Commercial and subsistence	7	21.9
Total	***32***	***100.0***
Fish commercial purpose Tilapia		
Table size	14	58.3
Table size and fillet production	3	12.5
Fingerling and Table size	4	16.7
Brooders, table fish and fillet production	2	8.3
Total	***24***	***100.0***
The commercial purpose of Catfish		
Table size	4	44.4
Table size and fillet production	2	22.2
Fingerling, brooders, table size and fillet production	2	22.2
Fingerling and table size	1	11.1
Total	***9***	***100***
The commercial purpose of Trout		
Fingerling, Table size and fillet	3	50.0
fingerlings, brooders, table size	3	50.0
Total	***6***	***100.0***

Rearing period and harvest weights variations

As shown in Table 5, the rearing period for tilapia, catfish, and trout averaged approximately 10.4, 10.2, and 12 months, respectively, with corresponding harvested average weights of 326.76 grams, 1357.14 grams, and 555 grams. These figures highlight variations in growth period and harvest weight across different counties. Growth rate, size at harvest, and feed conversion efficiency are key factors influencing species selection for aquaculture. Fish demonstrating superior performance in these areas typically reach market weight faster. The culture period can also be influenced by factors like targeting harvests for festive seasons or limited fish feed availability, which can impact the total quantity and value of fish harvested (Raufu et al., 2009).

For tilapia, standard aquaculture practices typically target a harvest weight of around 300 grams (Okechi, 2004). However, some farmers strategically harvest tilapia at higher weights (500-700 grams) despite the longer rearing time, aiming to capitalize on market demands. This trend is reflected in the observed harvest size range of 250 grams to 1 kilogram. Farmers harvesting at 500 grams achieved higher average prices compared to those harvesting at 300 grams. This aligns

Corresponding author: skomasaki@kisiiuniversity.ac.ke[1*]

with Kawarazuka's (2010) observation that larger fish are often sold to meet daily market needs, while smaller fish might be consumed domestically.

Fish marketing

Table 5 presents the farm-gate prices (KES) for fingerlings, table-size fish, and value-added fish products. Average prices for tilapia, catfish, and trout fingerlings were KES 9.7, KES 15, and KES 28.3, respectively. Mature table-size fish prices averaged KES 335 for tilapia, KES 540 for catfish, and KES 650 for trout. The price of table-size fish is influenced by species, weight, size, and thickness. Generally, trout fetched higher prices compared to other species. Heavier fish, believed to have more flesh (Omasaki et al., 2017), typically command premium prices, as observed in this study. Farmers often extended their rearing periods to achieve heavier fish, maximizing market returns. Value-added products commanded even higher prices, with tilapia, catfish, and trout averaging KES 700, KES 700, and KES 1200, respectively. However, majority of farmers were aware of value-addition and the extent of their involvement in this process was limited. Despite the potential for higher profits, fish value addition remains limited among Mount Kenya region fish farmers. This is attributed to several factors, including a lack of knowledge and skills in processing techniques, limited access to equipment like filleting machines or proper storage facilities, and infrastructure challenges in maintaining cold chains for chilled or frozen products in rural areas. These constraints hinder farmers from transforming their product and capturing a larger share of the value chain.

Results from this study highlight the crucial role of fish farming in the studied counties' rural household economies. Fish sales and value addition in fish farming serve as a powerful engine for rural development. They generate income for fish farmers, contribute to food security by providing a source of protein, and empower communities economically. Value addition practices further enhance these benefits by increasing product shelf life, marketability, and overall value, leading to higher profits and reduced post-harvest losses. By promoting fish sales and value addition, we can create a sustainable and thriving aquaculture sector that empowers rural communities and contributes to poverty reduction.

Corresponding author: skomasaki@kisiiuniversity.ac.ke[1*]

Table 5: Rearing period, harvesting size and prices for raw and value-added tilapia, catfish and trout across the three counties

Rearing period in months				
Fish species	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Tilapia	6.00	12.00	10.40	2.16
Catfish	6.00	12.00	10.25	2.49
Trout	8.00	16.00	12.00	3.27
Harvesting size in grams				
Tilapia	250.00	400.00	326.76	55.87
Catfish	700.00	2500.00	1357.14	789.21
Trout	250.00	1000.00	555.00	406.36
Fingerling prices in Kenya shillings (KES)				
Tilapia	4.00	15.00	9.7143	3.19970
Catfish	15.00	15.00	15.0000	0.00000
Trout	13.00	45.00	28.2500	16.60070
Prices for raw table size fish in Kenya shillings (KES)				
Tilapia	200.00	600.00	335.00	149.16
Catfish	250.00	800.00	540.00	277.04
Trout	300.00	1000.00	650.00	404.15
Price of value-added fishin Kenya shillings (KES)				
Tilapia	700.00	700.00	700.0000	0.0000
Catfish	700.00	700.00	700.0000	0.00000
Trout	1000.00	1400.00	1200.0000	282.84271

Conclusion

This study investigated fish farming practices in Nyandarua, Nakuru, and Nyeri counties of Kenya, targeting Nile tilapia, African catfish, and rainbow trout. Commercial fish farming dominated, with most farmers aiming to produce table-size fish for income generation. However, production objectives and rearing methods varied by species. The rearing period and price also differed by processing stage, with fingerlings fetching the lowest prices and value-added products commanding the highest. These findings offer valuable insights for promoting sustainable and profitable fish farming practices in Kenya.

Acknowledgements

The authors hereby thank World Bank for funding the Kenya Climate Smart Agricultural Project (KCSAP). The authors are thankful to farmers and to all those who participated in this study.

Conflict of interest

The author declares that there is no conflict of interest.

References

Blonk R.J.W., Komen J., Tenghe A., Kamstra A., van Arendonk J.A.M., 2010. Heritability of shape in common sole, Solea solea, estimated

Corresponding author: skomasaki@kisiiuniversity.ac.ke[1*]

from image analysis data. Aquaculture, 307, 6-11.

Butt T. M., Hassan Z. Y., Mehmoud K., Muhammad S., 2010. Role of Rural women in Agricultural Development and Their Constraints, Journal of Agriculture and Social Science 6(3): 53-56.

Economic Survey, 2021. Kenya National Bureau of Statistics, P.O Box 30266-00100 Real Towers, Upper Hill along Hospital Road, Nairobi .428 pp.

Food and Agriculture Organization (FAO)., 2014. The State of Fisheries and Aquaculture, Food and Agriculture Organization, Rome.

Food and Agriculture Organization (FAO)., 2018. The State of World Fisheries and Aquaculture, Food and Agriculture Organization, Rome.

Food and Agriculture Organization (FAO)., 2018. World Fisheries and Aquaculture 2018 - Meeting the Sustainable Development Goals. (Licence: C).

FAO. 2020. The State of World Fisheries and Aquaculture 2020. Sustainability in action. Rome. https://doi.org/10.4060/ca9229en

International Labour Organization, 2020. https://www.ilo.org/global/lang--en/index.htm. Accesed on 1 st March, 2022.

Kawarazuka N., Béné C., 2010. Linking small-scale fisheries and aquaculture to household nutritional security: an overview. Food Sec., 2, 343-357.

Kawarazuka, N., and C. Bene, 2010. Linking small-scale fisheries and aquaculture to household.nutritional security: An overview. Food Security 2(4): 343–357. DOI: 10.1007/s12571-010-0079-y.

Ndanga L.Z.B, Quagrainie K.K, Dennis J.H., 2013. Economically feasible options for increased women participation in Kenyan Aquaculture value chain. Aquaculture 415:183-190.

Nyandat, B., Owiti, G. O., 2013. *Aquaculture Needs Assessment Mission Report: Kenya*. SF-FAO/2013/24. Retrieved from http://www.fao.org/3/a-az041e.pdf.

Okechi J.K., 2004. Profitability assessment. A case of the African catfish (Clarias gariepinus) Farming in the Lake Victoria basin, Kenya. Project Submitted to United Nations University Iceland 70pp.

Omasaki, SK., Arendonk, J., Kahi, A., Komen, H., 2016. Defining a breeding objective for Nile tilapia that takes into account the diversity of smallholder

Corresponding author: skomasaki@kisiiuniversity.ac.ke[1*]

production systems. J. Anim. Breed. Genet. 133, 404–413.

Omasaki, SK., Charo-Karisa, H., Kahi, A., Komen, H., 2017. Genotype by environment interaction for harvest weight, growth rate and shape between monosex and mixed sex Nile tilapia (Oreochromis niloticus). Aquaculture 458, 75-81.

Opiyo, M. A., Marijani, E., Muendo, P., Odede, R., Leschen, W., Charo-Karisa, H., 2018. A review of aquaculture production and health management practices of farmed fish in Kenya. *International Journal of Veterinary Science and Medicine*, *6*(2), 141–148. https://doi.org/10.1016/j.ijvsm.2018.07.001.

Opiyo, M. A., Mugo, B. J., Kyule, D., Okemwa, G., 2017. Overview of Ornamental Fish Production in Kenya : Current Status ,. December 2016.

Raufu M O., Adepoju M O., Salau A S., Adebiyi O A., 2009. Determinants of yield performance in small scale fish farming in Alimosho Local Government Area of Lagos State. International Journal of Agricultural and Economics and Rural Development, 2(1), 9-14.

Sevilleja R., 2001. Adoption and economics of tilapia farming technology in the Philippines. https://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/30433/012.pdf?sequence=1. Accessed on 15 May, 2015. 8 pp.

Trọng T.Q., Mulder H.A., van Arendonk J.A., Komen H., 2013. Heritability and genotype by environment interaction estimates for harvest weight, growth rate, and shape of Nile tilapia (Oreochromis niloticus) grown in river cage and VAC in Vietnam. Aquaculture, 384, 119-127.

United Nations Development Program (UNDP), 2011. Human Development Report. Sustainability and Equity: A Better Future for All. 10 pp.

The World Bank, 2013. Hidden Harvest. The Global Contribution of Capture Fisheries. REPORT NO. 66469-GLB. 92pp.

Corresponding author: skomasaki@kisiiuniversity.ac.ke[1*]