integrity Research Journals

Global Journal of Fisheries Science
Volume 8(1), pages 1-10, February 2026
Article Number: 9B45AF501
ISSN: 2782-750X
https://doi.org/10.31248/GJFS2025.093
https://integrityresjournals.org/journal/GJFS

Full Length Research

Evaluating the economic performance of the aquaculture value chain in Lagos State, Nigeria

O. G. Falana*, A. A. Jimoh and G. O. Mekuleyi

Department of Fisheries, Lagos State University, Nigeria.

*Corresponding author. Email: samteekay@yahoo.com

Received 8th October 2025; Accepted 30th December 2025

ABSTRACT: The role of fish farmers, feed sellers, sellers of aquatic products and accessories, fish processors and fish mongers, among others, in Lagos state cannot be ignored. However, to date, there is no documented report on the economic performance of these actors in the agricultural zones of Lagos State. The sampling sites for the study were the three Agricultural Zones (Far Eastern, Eastern and Western) in Lagos State. A simple random sampling technique was adopted to select respondents, while data were collected using a structured questionnaire. Data were analysed using descriptive statistics (frequency and percentage) and inferential statistics (analysis of variance, principal component analysis (PCA). Economic performance was estimated with indices such as gross margin, net return on cost, net profit, net rate of return in ratio, benefit cost ratio, and return on investment. The estimated gross margin was highest for fish farming, and this was recorded in the western zone. However, the least gross margin was also recorded in the Western zone from sellers of aqua-products. The Return on Investment (ROI) for the fish farmers in the Eastern, Western and Far Eastern zones was 0.77, 0.64 and 0.47, respectively, implying that for every Naira invested in the business, there was a return of 77K, 64K, and 47K, respectively. The values of BCR for all the actors were above one (1), indicating potential to be very viable. In conclusion, the findings in this study have shed light on the complex interplay of efficiency within the aquaculture value-chain performance in Lagos State.

Keywords: Agricultural zones, economic performance, evaluation.

INTRODUCTION

The importance of aquaculture, especially towards increased fish production in developing a healthy country, cannot be ignored (Folorunso *et al.*, 2021). In most developing countries, aquaculture plays special roles in reducing poverty, enhancing good economic output, as well as food security (Gollin *et al*., 2021; von der Goltz *et al*., 2020). In the late 2000s, aquaculture value-chains emerged as a field of research among social scientists (Ababouch *et al*., 2023). Studies on the aquaculture value-chain usually incorporate concerns with value-chain structure, commonly expressed through mapping exercises (Asiedu *et al.*, 2017), the behaviour and action of value-chain actors and the performance of chains along the classes of actors within the aquaculture value-chain(Rosales *et al*., 2017). However, few studies of the aquaculture value-chain clearly operationalise structure, conduct and performance as their major analytical framework without addressing all three simultaneously. According to Ababouch *et al*. (2023), aquaculture did not only makes a remarkable contribution to food and nutrition security, economic development, employment, trade, and culture but aquaculture products have become one of the most globalized food commodities that attracts interest of international financial institutions, investors, agribusiness, retail organizations, as well as Non-Government Organizations, that usually examine the industry developments via the lenses of the Global Value Chain approach. This approach, known as the global commodity approach, investigates how the production, distribution and consumption of a given food commodity and its actors, services and economics are interconnected globally (FAO, 2020).

The aquaculture industry's value-chain could also be understood as firms either being involved in production and sales of fish, supply of technological solutions including equipment and consulting services, or supply of other products and services including feed production, fish

health products, and transport services (Aarstad *et al*., 2023). Scholars have studied how aquaculture value-chains are shaped and developed as well as how it can uncover insights into the networks, trust and constraints or challenges that face the sector (Kaminski *et al*., 2018). Bush *et al*. (2019) also addressed how the sector contributes to the sustainable expansion as an increasingly important component of the global food system. In their work, Aarstad *et al.* (2023) divulged that aquaculture firms across the value- chain and suppliers with both low and high sales to fish farming were not much affected by the COVID-19 pandemic, but they nonetheless had a strong proactive response to the crisis. However, within the agricultural zones in Lagos State, Nigeria there are several gaps in the knowledge of performance of aquaculture value- chain. The aim of the study is to investigate economic performance (costs and returns analysis) of businesses of aquaculture value-chain actors (feed seller, fish farmers, fish mongers, fish processors and sellers of aqua-product and accessories) in these zones.

MATERIAL AND METHODS

Study area

The study was conducted in the three Agricultural Zones (Far Eastern, Eastern and Western) in Lagos State, Nigeria. Lagos State is located in the South–Western part of Nigeria, on the narrow plain of the Bight of Benin, which lies on longitude 2° 42′E and 3° 22′E, and between latitude 6° 22′N and 6° 42′N (Soladoye and Ajibade, 2014). Lagos is bounded in the North and East by Ogun State of Nigeria, in the West by the Republic of Benin, and stretches over 180 kilometres along the Guinea Coast of the Bight of Benin on the Atlantic Ocean. Its major administrative divisions are Badagry, Epe, Ikeja, Ikorodu and Lagos, which cover 358,862 hectares (3,577 km^2) that represents 0.4% of Nigeria's territorial land mass of 923,773 km^2.

Two Local Government Areas (LGAs) were selected from each of the zones as a result of visible aquaculture activities in the zones. For the Eastern zone, Ikorodu and Somolu Local Government Areas (LGAs) were selected. Badagry and Alimosho were selected for the Western zone, while Epe and Eti-Osa were chosen for the Far Eastern zone (Figure 1).

Research design

The survey research design was adopted for this study. The descriptive survey method involves collecting data either through questionnaires, interviews, or direct observation in order to test hypotheses and answer questions raised in the study. This method was selected to be the most appropriate as a result of the purpose of the study.

Population of the Study

The population for this study consisted of stakeholders of the aquaculture value chain within the three agricultural zones in Lagos state.

Sampling technique

The study adopted a simple random sampling technique to pick the respondents from each Local government area. Also, an indication of positive response to the research consent forms influences the selection of respondents.

Pilot study of the instrument

Five samples of self-structured questionnaires were pre-tested on aquaculture enterprise actors in Ojo local government (LGA), and the feedback reports were noted. Thereafter, necessary adjustments were implemented on the questionnaire to ensure effective achievement of the objectives of this study.

Sample size

The sample size of the population of the study was determined by using the following equation:

$$n = \frac{N}{(N-1)(e)^2)}$$ (Yamane,1967)

Where n = sample size, N = population size, and e = 95% confidence level = 0.05.

Therefore, from the available statistics on the total population (N) of the practising fish farmers in the state, which is estimated to be over 5000 (Ministry of Agriculture (MOA) and Field Survey (FS) in 2021), n = 408. However, in order to have a large respondents, a minimum of 200 respondents were sampled from each selected local government area.

Data collection

The quantitative data were collected using a structured questionnaire, and a total of 400 questionnaires were administered at each agricultural zone. However, only 310 questionnaires (77.5%) were recovered from the Far Eastern zone, 285 questionnaires (71.3%) from the Eastern zone and 313 questionnaires (78.3%) from the Western zone.

Reliability of the instrument

Reliability test of the questionnaire was done using Cronbach's alpha, and all values ranged from 0.85 to 0.98.

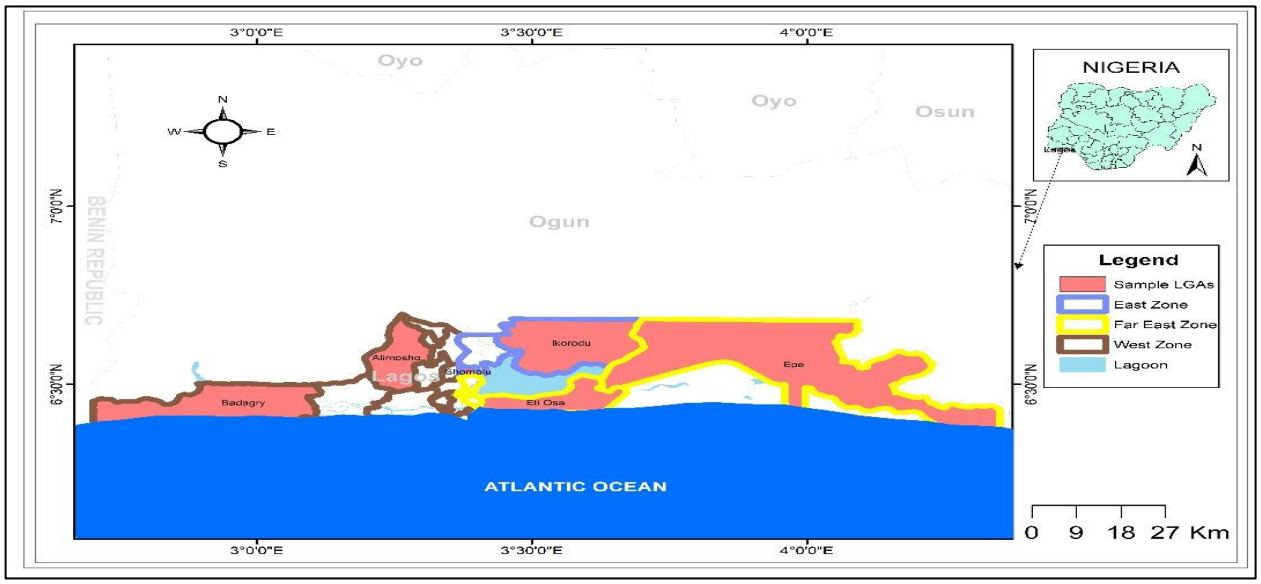

Figure 1. Map showing the location of selected local government areas within agricultural zones in Lagos State.

Determination of costs and returns of the aquaculture value chain

The following equations described by Abasilim *et al*. (2020) were used to determine the costs and returns of the enterprise.

GM= ΣTR- ΣTVC…… (i)

NM = GM –TFC …… (ii)

NROI = NM/TC ……..... (iii)

BCR = TR/TC ……..... (iv)

NM = net margin, GM = gross margin income, TVC = total variable cost, TFC = total fixed cost, NROI = net return on investment, TC = total cost, TR = total revenue and BCR = benefit-cost ratio.

Statistical analysis

Qualitative data were computed by organising the variables into general areas that were relevant and of interest and coded before analysing them using Statistical Package for the Social Sciences (SPSS) version 21. Data were analysed using descriptive statistics (frequency and percentage) and inferential statistics (Analysis of Variance). The similarity in the mean values was separated by post-hoc test using Least Significant Difference (LSD) at 95% confidence interval, with p-value of 0.05 or less being considered statistically significant. The equations described by Abasilim were used for economic analysis.

RESULTS

Composition of actors of the aquaculture value-chain within the agricultural zones

Presented in Table 1 are the percentages of the respondents among the various actors of the aquaculture value-chain within the agricultural zones (Far Eastern, Eastern and Western) of Lagos state. The total number of actors encountered as presented in Table 1 was 310, 285 and 313 in the Far Eastern, Eastern and Western zones, respectively. In the Far Eastern zone, most actors were fish farmers (96%), followed by fish mongers (23.23%), and the least were sellers of aqua-products (5.81%). Similarly, in the Eastern zone, most actors were fish farmers (31.97%), fish mongers (19.65%), with sellers of aqua-product (6.32%) being the least. Likewise, sellers of aquaculture accessories were the least (9.27%), while fish farmers (23.96%) dominated the actors in the Western zones.

Estimation of economic performance (costs and returns) of the aquaculture value-chain within agricultural zones in Lagos state

The results of the economic performance of the aquaculture value-chain (fish farmers, feed sellers, fish mongers, fish processors, sellers of aqua accessories, and sellers of aquatic products) within agricultural zones in Lagos state, are presented in Tables 2-7respectively. For the fish farmers (Table 2), there were significant differences ($p<0.05$) in the mean value of both the cost and revenue across the agricultural zones. Specifically, fish farmers in the Western zone recorded the highest cost (₦3,422,777±247,595.5) and highest revenue (₦5,620,550

Table 1. Percentage of respondents among selected aquaculture value-chain actors in Lagos State.

Agricultural zones	Aquaculture Value-chain actors	Frequency	Percent (%)
	Fish farmers	96	30.97
	Fish mongers	72	23.23
	Processors	60	19.35
Far Eastern	Seller of aqua-accessories	42	13.55
	Feed sellers/producers	22	7.09
	seller of aqua products	18	5.81
	Total	310	100
	Fish farmers	91	31.93
	Fish mongers	56	19.65
	Processors	39	13.68
Eastern	Seller of aqua-accessories	27	9.47
	Feed sellers/producers	54	18.95
	seller of aqua products	18	6.32
	Total	285	100
	Fish farmers	75	23.96
	Fish mongers	60	19.17
	Processors	47	15.01
Western	Seller of aqua-accessories	29	9.27
	Feed sellers/producers	52	16.62
	seller of aqua products	50	15.97
	Total	313	100

Table 2. Average monthly cost elements, revenue and profitability indices of fish farmers within agricultural zones in Lagos State.

Variables	Eastern Zone	Western	Far Eastern
Unskilled labour	150000±8120.50[a]	400100±6850[b]	200000±10125[c]
Insurance	-	-	-
Raw materials	300230±5480[a]	300560±21300[b]	200000±11690[c]
Salary of permanent staff	100260±1580[a]	450000±2265 [b]	320000±2845 [c]
Rent of land/shop/pond	12000±4800[a]	40700±5128 [b]	-
Machinery and equipment (Purchase/rent)	400000±5320[a]	150000±4350[b]	250000±20200 [c]
Transportation cost	200000±5800[a]	80000±4900 [b]	180000±6100 [c]
Cost of feed(Imported/local)	300000±6900[a]	900000±3545[b]	300000±6850 [a]
Tax	4500± 800[a]	3000±950 [b]	5000±460 [c]
Physical inputs(fuel, electricity, chemicals etc)	40300 ± 3500[a]	290000±4120 [b]	154000±6090 [c]
Technical assistance	15000±4500[a]	100000±2450 [b]	25000±12300 [c]
Repair services	30000±1065[a]	100000±2850 [b]	50000±4220 [c]
After sales services	28000±1630 [a]	12000±1230 [b]	25000±3200 [c]
Family and Friends (Gift of products)	3000±500.85[a]	8000±250.90[b]	6000±560.80 [c]
Loan servicing	-	-	-
Purchase of fish seeds/breeding	150000±3280[a]	500000±5590 [b]	340000±6120 [c]
Extension service	50000±2400[a]	50000±3120 [b]	32000±2560 [c]
Miscellaneous (Exingences)	35650±1860[a]	38417±6895.60 [b]	27560±4900.20 [c]
Sum of Mean Total Cost	1818940±104670[a]	3422777±247595.5[b]	2114560± 12367 [c]
Sum of Mean Total Revenue	3214000±15,205[a]	5620550 ±22,560[b]	3109000±12,650 [c]
GM (TR-TVC)	1795060	2347773	1244440
Net return on Cost (GM/TVC)	1.27	0.72	0.67
NP = GM-TVC	376120	925004	620120
NRR =NP/TC	0.21	0.27	0.29
BCR (TR/TC)	1.77	1.64	1.47
ROI(NM/TC)	0.77	0.64	0.47

Differences among data were analyzed using ANOVA while mean values with different superscripts in the row are significantly different ($p<0.05$).GM = Gross margin, TR = Total revenue, TVC =Total variable cost, TFC =Total fixed cost, TC= Total cost, NP=Net profit, NRR = Net rate of return in ratio. BCR = Benefit cost ratio, ROI = Return on investment, NM= Net margin.

Table 3. Average monthly cost elements, revenue and Profitability indices of Feed sellers within agricultural zones in Lagos State.

Variables	Zone [Amount (₦)]		
	Eastern	Western	Far Eastern
Unskilled labour	15700±4424.81[a]	20812±3816.26[b]	12000±4214.36[c]
Insurance	5200±808.29[a]	3600±785.12[b]	4200±808.43[c]
Salary of permanent staff	67560 ±12921.32[a]	70000±11050.22[b]	62360±12654.45[c]
Rent of land/shop	11420±1824.31[a]	15000±1836.25[b]	12600±1824.17[c]
Transportation cost	62000±10884.62[a]	80420±9776.89[b]	58200±9923.24[c]
Cost of feed (Imported/local) from dealer	534000±19716.09[a]	650000±18426.09[b]	525000± 17716.18[c]
Tax	-	-	-
fuel, electricity, chemicals etc)	3750±732.00[a]	4300±718.30[b]	5200±684.50[c]
Technical assistance	4000±2369.24[a]	8000±2350.12[b]	3800±2289.43[c]
Repair services	-	-	-
After sales services	-	-	-
Family and Friends (Gift of products)	2800±850.49[a]	4500±780.49[b]	3600±832.14[c]
Loan servicing	25000±7229.38[a]	10700±8129.80[b]	16000±7409.65[c]
Extension service	2000±840.83[a]	4000± 1040.83[b]	2500±850.56[c]
Miscellaneous (Exingences)	6400±703.42[a]	5000±700.56[b]	5000±703.42[b]
Sum of Mean Total Cost	739830± 5275.40[a]	876332±4950.91[b]	710460±4992.54[c]
Sum of Mean Total Revenue	1486900± 3883.24[a]	1660650± 8275.14[b]	1630760±5883.20[c]
GM (TR-TVC)	758490	799318	932900
Net return on Cost (GM/TVC)	1.04	0.92	1.31
NP = GM-TVC	30080	62014	235040
NRR= NP/TC	0.04	0.07	0.33
BCR (TR/TC)	2.00	1.90	2.30
ROI (NM/TC)	1.00	0.89	1.30

Differences among data were analyzed using ANOVA while mean values with different superscripts in the row are significantly different (p<0.05).GM = Gross margin, TR = Total revenue, TVC =Total variable cost, TFC =Total fixed cost, TC= Total cost, NP=Net profit, NRR = Net rate of return in ratio. BCR = Benefit cost ratio, ROI = Return on investment, NM= Net margin.

Table 4. Average monthly cost elements, revenue and profitability indices of fish mongers within agricultural zones in Lagos State**.**

Input category	Zone [Amount (₦)]		
	Eastern	Western	Far Eastern
Unskilled labour	10500±1409.20[a]	12000±978.25[b]	11600±1100.06[c]
Insurance	-	-	-
Raw materials	167560±12921.32[a]	182000±11050.22[b]	181360±10654.5[c]
Salary of permanent staff	20800±1224.31[a]	15000±1836.25[b]	12600±1824.17[c]
Rent of land/ Space	8000±684.62[a]	7500±1076.89[b]	10500±828.25[c]
Transportation cost	20300±3156.80[a]	25000±2450.45[b]	21800±3780.50[c]
Tax	-	-	-
Physical inputs (fuel, electricity etc)	5000±655.46[a]	4000±913.45[b]	2500±500.65[c]
Repair services	2100±1020.35[a]	3520±1100.50[b]	2750±1065.42[c]
Family and Friends (Gift of products)	2500±1250.82[a]	3200±1050.56[b]	3850±1132.36[c]
Loan servicing	10000±1004.23[a]	12000±1235.06[b]	14500±1000.22[c]
Purchase of table size fish	454630±3567.80[a]	350000±4200.62[b]	428300±6100.42[c]
Miscellaneous (Exingences)	6540±2105.45[a]	4850±1860.22[b]	3625±1025.48[c]
Sum of Mean Total Cost	707930±5423.25[a]	619070±7345.91[b]	693385±5654.25[c]
Sum of Mean Total Revenue	1092760±4321.34[a]	1150900±2246.46[b]	1380760±1689.36[c]
GM (TR-TVC)	384830	531830	687375
Net return on Cost (GM/TVC)	0.55	0.87	1.00
NP = GM-TVC	-315100	-79740	4490
NRR =NP/TC	-0.45	-0.13	0.01
BCR (TR/TC)	1.54	1.86	1.99
ROI(NM/TC)	0.53	0.85	0.98

Differences among data were analyzed using ANOVA while mean values with different superscripts in the row are significantly different (p<0.05).GM = Gross margin, TR = Total revenue, TVC =Total variable cost, TFC =Total fixed cost, TC= Total cost, NP=Net profit, NRR = Net rate of return in ratio. BCR = Benefit cost ratio, ROI = Return on investment, NM= Net margin.

Table 5. Average monthly cost elements, revenue and profitability indices of fish processors within agricultural zones in Lagos State.

Variables	Zone [Amount (₦)]		
	Eastern	Western	Far Eastern
Unskilled labour	20100±1424.81[a]	20812±3816.26[b]	16000±2214.36[c]
Insurance	3200±808.29[a]	4600±785.12[b]	5200±808.43[c]
Raw materials	72460 ±12921.32[a]	75000±11050.22[b]	68360±12654.45[c]
Salary of permanent staff	12420±1824.31[a]	15000±1836.25[b]	18600±1824.17[c]
Rent of land/shop	8500±10884.62[a]	8420±9776.89[b]	6800±9923.24[c]
Machinery and equipment(rent)	30400±19415.09[a]	35000±18426.09[b]	25000± 12716.18[c]
Transportation cost	12000±1824.31[a]	15600 ± 2124.31[b]	23000 ±1424.62[c]
Tax	4000±1069.24[a]	4500±1150.12[b]	5800±1289.43[c]
Physical inputs (fuel, electricity, chemicals	6500±1224.31[a]	3400±1824.30[b]	3600±1524.25[c]
Technical assistance	5000±1084.24[a]	3600±1564.91[b]	4560 ±1824.31[c]
Repair services	2800±870.49[a]	4500±780.49[b]	3600±862.44[c]
After sales services	6000±1229.38[a]	7000±1129.80[b]	6000±1409.65[c]
Family and Friends(Gift of products)	3500±840.83[a]	4200± 1040.83[b]	2900±850.56[c]
Loan servicing	10400±1703.42[a]	15000±1700.56[b]	5000±1503.42[c]
Purchase of table size fish	659830± 5275.40[a]	776332±4950.91[b]	710460±4992.54[c]
Miscellaneous (Exingencies)	25690±1056.46[a]	32968±2424.41[b]	27310±1224.65[c]
Sum of Mean Total Cost	882800±5642.45[a]	1025932±10235.65[b]	932190±5409.65[c]
Sum of Mean Total Revenue	1356430±3213.24[a]	1473346±6184.56[b]	1483346±6184.56[c]
GM (TR-TVC)	504030	505834	587956
Net return on Cost (GM/TVC)	0.59	0.52	0.66
NP = GM-TVC	348370	485098	551156
NRR =NP/TC	0.39	0.47	0.59
BCR (TR/TC)	1.54	1.44	1.59
ROI(NM/TC)	0.54	0.46	0.63

Differences among data were analyzed using ANOVA while mean values with different superscripts in the row are significantly different ($p<0.05$).GM = Gross margin, TR = Total revenue, TVC =Total variable cost, TFC =Total fixed cost, TC= Total cost, NP=Net profit, NRR = Net rate of return in ratio. BCR = Benefit cost ratio, ROI = Return on investment, NM= Net margin.

Table 6. Average monthly cost elements, revenue and profitability indices of seller of aqua- accessories within agricultural zones in Lagos State.

Input category	Zone [Amount (₦)]		
	Eastern	Western	Far Eastern
Insurance	6200±1020.22[a]	7125±1032.10[b]	6480±1055.14[a]
Raw materials	267860 ±12921.32[a]	198000±11050.22[b]	188360±10654.5[c]
Salary of permanent staff	34700±1224.31[a]	28000±1836.25[b]	22600±1824.17[c]
Rent of land/shop	15000±1884.62[a]	10150±1776.89[b]	10500±923.24[c]
Transportation cost	18000±1120.5[a]	14500±1160.80[b]	18230±1020.75[c]
Tax	5600±1369.24[a]	5500±1350.12[b]	4800±1089.43[c]
Physical inputs (fuel, electricity etc)	6450±1125.40[a]	4660±1020.20[b]	5460±1000.80[c]
Repair services	3600±750.49[a]	4400±580.49[b]	5000±832.54[c]
Family and Friends (Gift of products)	3600±625.83[a]	4000± 840.85[b]	4500±850.56[c]
After sales services	25000±7229.38[a]	10700±8129.80[b]	16000±7409.65[c]
Loan servicing	10400±703.42[a]	15000±700.56[b]	18500±703.42[b]
Miscellaneous (Exigencies)	7069±1120.4[a]	5968±1050.6[b]	6100±1065.4[b]
Sum of Mean Total Cost	399879±2567.16[a]	308003±4320.86[b]	306530±1245.65[c]
Sum of Mean Total Revenue	590700±5100.60[a]	494760±3256.40[b]	568300±4385.26[c]
GM (TR-TVC)	221821	211907	290770
Net return on Cost (GM/TVC)	0.60	0.75	1.05
NP = GM-TVC	190821	186757	248530
NRR =NP/TC	0.48	0.61	0.81
BCR (TR/TC)	1.98	1.60	1.85
ROI(NM/TC)	0.55	0.69	0.95

Differences among data were analyzed using ANOVA while mean values with different superscripts in the row are significantly different ($p<0.05$).GM = Gross margin, TR = Total revenue, TVC =Total variable cost, TFC =Total fixed cost, TC= Total cost, NP=Net profit, NRR = Net rate of return in ratio. BCR = Benefit cost ratio, ROI = Return on investment, NM= Net margin.

Table 7. Average monthly cost elements, revenue and Profitability indices of seller of aquatic products within agricultural zones in Lagos State.

Input category	Zone [Amount (₦)]		
	Eastern	Western	Far Eastern
Unskilled labour	15000±1200.5[a]	18100±1086.8[b]	22200±1134.3[c]
Insurance	-	-	-
Raw materials	167560±12921.32[a]	182000±11050.22[b]	181360±10654.5[c]
Salary of permanent staff	20800±1224.31[a]	15000±1836.25[b]	12600±1824.17[c]
Rent of land/shop	12000±1884.62[a]	10420±1776.89[b]	11500±923.24[c]
Transportation cost	8000±1020.5[a]	6500±1160.80[b]	10230±1020.75[c]
Tax	3600±1369.24[a]	4500±1350.12[b]	3800±1289.43[c]
Physical inputs (fuel, electricity etc)	6850±1125.40[a]	4360±1020.20[b]	5460±1050.80[c]
Repair services	2700±750.49[a]	4600±580.49[b]	3600±832.54[c]
Family and Friends (Gift of products)	3600±625.83[a]	4000± 840.85[b]	4500±850.56[c]
Miscellaneous (Exingences)	7069±1120.4[a]	5968±1050.6[b]	6100±1065.4[b]
Sum of Mean Total Cost	247179±2156.56[a]	255448±1623.45[b]	261350±1036.56[c]
Sum of Mean Total Revenue	349070±5100.60[a]	334760±3256.40[b]	395300±2385.44[c]
GM (TR-TVC)	117491	94232	149250
Net return on Cost (GM/TVC)	0.51	0.39	0.60
NP = GM-TVC	101891	79312	133950
NRR =NP/TC	0.41	0.31	0.51
BCR (TR/TC)	1.41	1.31	1.51
ROI(NM/TC)	0.48	0.37	0.57

Differences among data were analyzed using ANOVA while mean values with different superscripts in the row are significantly different ($p<0.05$).GM = Gross margin, TR = Total revenue, TVC =Total variable cost, TFC =Total fixed cost, TC= Total cost, NP=Net profit, NRR = Net rate of return in ratio. BCR = Benefit cost ratio, ROI = Return on investment, NM= Net margin.

±22,560), while the least cost (₦1,818,940±104,670) and revenue (₦3,109,000±12,650) were recorded in the Eastern and Far Eastern zones, respectively. The gross margin (GM) and net profit (NP) of the fish farmers were highest in the Western zone, and at least were recorded in the Far Eastern and Eastern zones, respectively. However, the values of net rate of return in ratio (NRR), benefit cost ratio (BCR), and return on investment (ROI) were approximately similar across the agricultural zones.

or the feed sellers, the GM was highest in the Far Eastern zones (₦932,900) and least in the Eastern zone (₦758,490). The BCR in all the zones were greater than one (>1), while the ROI and NRR of feed sellers in the Western zone were < 1. However, there were significant differences in mean cost and revenue for feed sellers in the agricultural zones (Table 3).

The economic analysis for the fish mongers and processors is shown in Tables 4 and 5, while the economic performance of sellers of aqua accessories and sellers of aquatic products is shown in Tables 6 and 7, respectively. The costs and revenues across agricultural zones were different, but all had GM, NP, NRR, BCR, and ROI that were statistically similar across the agricultural zones.

Correlation of economic index and regression analysis of economic performance variables within agricultural zones in Lagos

The relationship between the economic index and regression analysis is presented in Table 8. There is significant correlation ($p<0.01$, $p<0.05$) between NP versus (vs) GM, NP vs NRR, and NP vs ROI. Also, a significant correlation existed between GM vs NRR and ROI, while BCR was significantly correlated with ROI. The regression analysis showed a strong relationship (0.837) among the economic indices.

DISCUSSION

Value chain entails progressive relationships via which production resources and inputs are changed to products and brought into the market for the final user. It identifies actors (primary and secondary actors) and a set of activities involved in at each chain node towards conveying raw agricultural products from production in the field to final consumption, where at each stage value is added to the product (Coulibaly *et al.,* 2010). In the catfish value chain, seven main actors, namely input suppliers, producers, processors (smoked, frozen, barbeque, and fillet), marketers, transporters, associations and consumers, have been identified (Gbigbi and Achoja, 2019).In this study, the majority of actors within the aquaculture value-chain from the Far Eastern, Eastern and Western zones in the agricultural zones of Lagos State were fish farmers, while the least prevalent were sellers of aqua-products and aquatic accessories. This observation implies that fish farmers (producers) play an important role in the aquaculture value-chain process of Lagos State, and

Table 8. Pearson Correlations of economic performance index within agricultural zones in Lagos.

Correlations		NP	GM	NRR	BCR	ROI	Zones
NP	Pearson Correlation	1	0.994**	0.921**	0.413	0.541*	-0.005
	Sig. (2-tailed)		0.000	0.000	0.089	0.020	0.985
GM	Pearson Correlation	0.994**	1	0.886**	0.418	0.560*	-0.018
	Sig. (2-tailed)	0.000		0.000	0.085	0.016	0.944
NRR	Pearson Correlation	0.921**	0.886**	1	0.297	0.370	0.025
	Sig. (2-tailed)	0.000	0.000		0.232	0.131	0.921
BCR	Pearson Correlation	0.413	0.418	0.297	1	0.888**	-0.003
	Sig. (2-tailed)	0.089	0.085	0.232		0.000	0.992
ROI	Pearson Correlation	0.541*	0.560*	0.370	0.888**	1	0.114
	Sig. (2-tailed)	0.020	0.016	0.131	0.000		0.653
Zones	Pearson Correlation	-0.005	-0.018	0.025	-0.003	0.114	1
	Sig. (2-tailed)	0.985	0.944	0.921	0.992	0.653	

**. Correlation is significant at the 0.01 level (2-tailed); *. Correlation is significant at the 0.05 level (2-tailed).

thus, based on the population strength of fish farmers in these zones, the fish farmers stand better chances to influence the sustainability of the aquaculture value-chain in the agricultural zones of Lagos State.

In line with the findings in this study, fisherfolk have always formed the majority of key actors of the fisheries value chain (Abasilim *et al.*, 2020; Anetekhai *et al*., 2022). Furthermore, Ajayi *et al*. (2022) and FAO (2023) reported that through fish farming, Nigeria is ranked as the leading aquaculture-producing nation in Sub-Saharan Africa and is currently the largest producer of African catfish in the world. The engagement of a large population of fish farmers in the aquaculture value chain of Lagos State could be attributed to the fact that fish is an important source of protein-rich food, and there has been a rapid increase in the demand for fish products due to increasing population (Fawehinmi *et al*., 2017).

All the performance index used to estimate the economic status of aquaculture value-chain within the agricultural zones in Lagos state that were computed from costs and revenue of the individual stakeholders showed significant differences in the mean values for each economic variable across Eastern, Western and Far Eastern zones, and this indicated that there are variants in the revenue generated by each actor in the value-chain and such variation might be due to many factors including cost of operation, location and status of buyers among others (Joseph *et al*., 2024). In this study, the estimated gross margin was highest for the fish farming business (coordinated by fish farmers) across the aquaculture value chain, and this was recorded in the Western zone, followed by the Eastern zone. However, the least gross margin was recorded in the same Western zone from sellers of aqua-products. This observed gross margin could imply that the fish farming business from the Western zone is generating more profit from each sale than other aquaculture value-chain stakeholders within the agricultural zones of Lagos state, and that the business has more room to absorb fluctuation in sales or expenses. However, the gross margin recorded in this study was higher than that reported by Abasilim *et al.*(2020) (₦ 16,695.25 for fisherfolks, ₦29,548.90 for fish processors and ₦33,773.00 for fish marketers) and Joseph *et al*.(2024) (₦33,449.00 for fish marketers and ₦957,954.5 for fisherfolks).

The value for net returns favours the feed sellers more than other stakeholders within the aquaculture value chain, however, the net rate of return in ratio (NRR) which favours fish processing business above other aquaculture value-chain (and was highest at the Far Eastern zone) indicated that business of processing generates more profit relative to cost, while the fish mongers had the least NRR. Agbebi *et al*. (2020) highlighted that business experience could also contribute immensely to the profitability of an aquaculture business. Similarly, an assertion was made by Joseph *et al*. (2024) that fishing experience determines the profit levels of artisanal fisher folks. On the other hand, the net profit was highest in fish farming (done by fish farmers), and it was recorded in the Western zone, followed by the Far Eastern zone, while fish mongers (at Eastern and Western zones) had a loss (negative net profit). Return on Investment (ROI) values for most aquaculture enterprises across the agricultural zones indicate that these enterprises remain profitable. For instance, ROI for the fish farmers in the Eastern, Western and Far Eastern zones, which were 0.77, 0.64 and 0.47, respectively, implying that for every Nigerian Naira invested in the business, there is a return of 77k, 64k, and 47k, respectively (1 Naira = 100 kobo). Similar reports were made by Abasilim *et al.* (2020) and Boro and Agbugba (2022), indicating that for every Nigerian Naira invested, there is a return of 13k for the fisherfolk, 70k for the fish processor, and 0.58 for the fisherfolk, fish processor, and fish marketer, respectively. Variation in NROI for the chain was attributed to varying high investment start-up costs for the different actors. Joseph *et al.* (2024) reported that the higher gross margin

estimates and ROI indicated that the more the amount invested in the business, the greater the net revenue. The values of BCR documented in this study, which were above 1 for all the aquaculture enterprises, also buttressed that the aquaculture enterprises within agricultural zones in Lagos state still have potential to be very viable. However, all the BCR values in this study were greater than those reported by Nse-Nelson and Oke (2015), Abasilim *et al*. (2020), and Ogunbanwo *et al*. (2021), who reported BCR values which ranged from 1.13-1.15 for fisher folk, 1.70-1.74 for fish processors and 1.28- 1.60 for fish marketers.

Conclusion

The aquaculture value-chain in the Far Eastern, Western and Eastern zones of Lagos State has long-term potential for viability, and therefore it must be sustained by all stakeholders as well as the government. The selected agricultural zones, as well as the examined aquaculture value chain, contributed significantly to the household economy of the people within the zones and Lagos State at large. Therefore, the study provides baseline data on economic performance among the aquaculture value chain, and this report would immensely guide all stakeholders, especially researchers, community leaders, industry, and policy makers, on the need to preserve businesses within the aquaculture value chain in Nigeria.

Recommendation

Sequel to the findings in this study, periodic seminars should be organised for all stakeholders within the aquaculture value chain so as to be more enlightened on the best way and practices to maximise profits without compromising the sustainability of the aquaculture sector. Also, there should be restructuring in the policy of aquaculture of Lagos State as well as implementation toward sustainability of the sector. Moreso, research should be carried out on the evaluation of the economic worth of other popular value chains, such as crop production in Lagos State. The economic performance indices used in this study can be applied as reliable tools for the determination of the viability of other value chains in agriculture, such as crop production, biofuel, cocoa, dairy, livestock production, and fisheries value chains.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

REFERENCES

Aarstad, J., Jakobsen, S. E., & Fløysand, A. (2023). Norwegian aquaculture firms' Emphasis on environmental and social sustainability compared to firms in other industries. *Fishes*, *8*(2), 115.

Ababouch, L., Nguyen, K. A. T., Castro de Souza, M., & Fernandez-Polanco, J. (2023). Value chains and market access for aquaculture products. *Journal of the World Aquaculture Society*, *54*(2), 527-553.

Abasilim, C. F., Samuel, O. B., & Onyewuchi, I. V. (2020). Economic analysis of artisanal fisheries value chain in Epe Lagoon, Lagos State, Nigeria. *Ife Journal of Agriculture*, *32*(2), 91-101.

Agbebi, F. O., Ikuerowo, J. O., & Ogunsakin, O. Y. (2020). Profitability analysis of artisanal fishing in Ilaje Coastal Communities of Ondo State. *American Journal of Rural Development*, *8*(1), 12-16.

Ajayi, O., Akinrinlola, A., Usman, A., Muhammed, A., & Vander-Knaap, M. (2022). Aquaculture development in Nigeria and FAO's Role. In FAO Aquaculture News—International Year of Artisanal Fisheries and Aquaculture 2022; Special Issue; FAO: Rome, Italy. Pp. 21-24.

Anetekhai, M. A., Mekuleyi, G. O., & Aderinola, O. J. Economics Evaluation of Ecological Services of Some Aquatic Ecosystems in Badagry Division, Lagos, Nigeria. *Asian Journal of Environment and Ecology*, 18(4), 42-50.

Asiedu, B., Adetola, J. O., & Odame Kissi, I. (2017). Aquaculture in troubled climate: Farmers' perception of climate change and their adaptation. *Cogent Food & Agriculture*, *3*(1), 1296400.

Boro, F. E., & Agbugba, I. K. (2022). Economics of artisanal fish production in Gokana local government area of Rivers State, Nigeria. *Journal of Business Strategy Finance and Management*, *4*(2), 202-213.

Bush, S. R., Belton, B., Little, D. C., & Islam, M. S. (2019). Emerging trends in aquaculture value chain research. *Aquaculture*, *498*, 428-434.

Coulibaly, O., Arinloye, D., Melle, C., Fanou, J., Agbahey, J., Allomasso, R., Nouhoheflin, T., Koumassa, L., Adetonah, S. & Hell, K. (2010). Value chain analysis: Analytical toolkit and approaches to guide the development of sustainable African Agrifood Chains IITAIFADPRONAF (Cowpea Project for Africa). An IFAD Grant Training Course.

Food and Agriculture Organization (FAO) (2023). *Unlocking the Potential of Sustainable Fisheries and Aquaculture in Africa, the Caribbean and the Pacific—Nigeria*; FISH4ACP Factsheet; FAO: Rome, Italy, 2023; Retrieved 23rd September 2023 from https://www.fao.org/in-action/fish-4-acp/where-we-work/africa/nigeria/ru/.

Food and Agriculture Organization (FAO) (2020). *The State of World Fisheries and Aquaculture*. Rome, Italy. Retrieved from https://www.fao.org/ documents/card/en/c/I9540EN/.

Fawehinmi, O., Omitoyin, S. and Jim-George, O. (2017). Determinants of output of small scale fish farmers inIkorodu, Nigeria. *African Journal of Fisheries and Aquatic Resources Management*, 2, 55-65.

Folorunso, E. A., Rahman, M. A., Sarfo, I., Darko, G., & Olowe, O. S. (2021). Catfish farming: a sustainability study at Eriwe fish farming village in southwest Nigeria. *Aquaculture International*, *29*(2), 827-843.

Gbigbi, T. M., & Achoja, F. O. (2019). Cooperative financing and the growth of catfish aquaculture value chain in Nigeria. *Croatian Journal of Fisheries*, *77*(4), 263-270.

Gollin, D., Hansen, C. W., & Wingender, A. M. (2021). Two blades of grass: The impact of the green revolution. *Journal of Political Economy*, *129*(8), 2344-2384.

Joseph, O. O., Mekuleyi, G. O., Jimoh, A. A., & Jakkari, B. S. (2024). Economic analysis of operation of artisanal fisherfolks and fish marketers associated with three creeks in Lagos,

Nigeria. *Lagos Journal of Contemporary Studies in Education*, *2*(1),102-112.
Kaminski, A. M., Genschick, S., Kefi, A. S., & Kruijssen, F. (2018). Commercialization and upgrading in the aquaculture value chain in Zambia. *Aquaculture*, *493*, 355-364.
Nse-Nelson, F. A., & Oke, U. R. (2015). Economics of fish marketing by women in Aba Agricultural Zone of Abia State, Nigeria. *International Journal of Applied Research and Technology*, 4(6), 26-31.
Ogunbanwo, O. M., Okeowo, T. A., & Adeniyi, T. (2021). Economics of fish farming in Ikorodu Area of Lagos State, Southwest Nigeria. *International Journal of Advanced Research and Review*, *6*(4), 27-34.
Rosales, R. M., Pomeroy, R., Calabio, I. J., Batong, M., Cedo, K., Escara, N., acunla, V., Gulayan, A., Narvadez, M., Sarahadil, M., & Sobrevega, M. A. (2017). Value chain analysis and small-scale fisheries management. *Marine Policy*, *83*, 11-21.
Soladoye, O., & Ajibade, L. T. (2014). A groundwater quality study of Lagos State, Nigeria. *International Journal of Applied Science and Technology*, *4*(4), 271-281.
von Der Goltz, J., Dar, A., Fishman, R., Mueller, N. D., Barnwal, P., & McCord, G. C. (2020). Health impacts of the green revolution: Evidence from 600,000 births across the developing world. *Journal of health economics*, *74*, 102373.
Yamane, T. (1967). *Statistics: An Introductory Analysis*, 2nd Ed., New York: Harper and Row.