p-ISSN 0044-1600
e-ISSN 2392-3458

Zagadnienia Ekonomiki Rolnej
Problems of Agricultural Economics

www.zer.waw.pl

4(369) 2021, 154-169

DOI: 10.30858/zer/142780

Research Papers

PROFITABILITY AND PROFIT EFFICIENCY OF CATFISH FINGERLINGS PRODUCTION IN EDO SOUTH, NIGERIA

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Abstract

This study used descriptive statistics, budgetary analysis, and stochastic profit function to analyze data collected from 120 catfish fingerlings producers in Edo State, Nigeria to examine the profitability and profit efficiency of their production. Results from the study show that catfish fingerlings production is a male dominated activity with a modal age of 21-40 years and 53.3% engaged full time as fingerlings producers. Clarias gariepinus *was the dominant species used for fingerlings production. Producers earn a revenue of NGN 2,885,443.2 and make NGN 2,084,004.24 as net profit per production cycle 120,000 implying that catfish fingerlings production is a profitable venture in the study area. Labor cost, depreciation, and cost of transportation affected the profits of fingerlings producers positively in that they led to an increase in their normalized profit. About 70% of the catfish fingerlings producers operated above the mean efficiency value implying that most of the farmers were relatively efficient in profit making. Inadequate water supply, cost of feed, high cost of transportation, and inadequate*

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funds were the major constraints faced by the respondents in the study area. Pest and disease outbreaks were not serious constraints. The study therefore recommends that causes of inefficiencies should be considered and treated so as to enhance higher efficiencies by catfish fingerlings producers and to operate at the optimum profit frontier. It is also recommended that solutions should be proffered to constraints to catfish fingerlings production by concerned authorities to make the venture sustainable in meeting with demands all year round.

Keywords: profitability, efficiency, *Clarias gariepinus*, fingerlings, production, Edo South.

JEL codes: Q1, Q13, D13, O13.

Introduction

Globally, fish farming is considered an important agricultural activity that is capable of ending nutritional deficiencies of the world and contributing to poverty reduction. It meets the food security needs of millions of people in developing countries who will benefit from it as it is a source of relatively inexpensive protein (Kaleem and Abudou-Fadel, 2020). In Nigeria, monoculture which is the conscious rearing of single species at a particular point in time is practiced when the fish involved has good commercial value as with the case of catfish. Fish culture alone is reported to have the potential to supply the Nigeria fish requirement and produce excesses for export generation and foreign exchange (Grema et al., 2015).

Catfishes of the genus *Clarias* (Siluroidei, Claridae) are widespread in tropical Africa and Asia (Sudarto, 2007). *Clarias gariepinus*, popularly known as catfish in Nigeria, is by far the most cultivated. However, they do not normally reproduce spontaneously in ponds. This leads to shortage in seed (reproductive and replacement stock) availability. Induced breeding with production systems and hatchery management techniques that make catfish seed of good quality readily available to all farmers have been established in most African countries (Pouomogne, 2008). Nigeria contributes more than 67% of the total global production of catfish fingerlings, followed by Uganda, Cuba, Sudan, Hungary, the Netherlands, Benin, and Brazil (FAO, 2019) and is the largest producer of catfish in Africa and the world and the second-largest aquaculture producer in Africa after Egypt (Dauda, Natrah, Karim, Kamarudin, Bichi, 2018).

Asa and Obinaju (2014) confirmed that Nigerian fish farmers focus on catfish species such as *Clarias gariepinus*, *Heterobranchus bidorsalis* and *Heteroclarias claridae* because they adapt well to culture environment, can be retailed live and they attract premium price. Catfish production is perceived as a viable investment by investors as it provides cheap and quality protein, creates employment opportunity, as well as constitutes an important element in the social stability and progress of the people in Nigeria. All these aspects indicate that catfish production can go a long way in the attainment of the millennium development goals (Adelakun et al., 2015). Similarly, Emokaro et al., (2010) asserted that catfish production serves as a source of income, reduces the rate of unemployment in the economy, increases the gross domestic product (GDP), could be sold live in the market, and has a market value two to three times that of tilapia. Kudi et al. (2008) show that fish production in Kaduna State, Nigeria was profitable after realizing a net income of NGN 5,282, 393.85 from 9,637 fishes sold at NGN 624.92 per 1.12 kg table fish size. Aquaculture has, therefore, become an important alternative to increase domestic fish production in Nigeria and, globally, it has been projected to overtake the capture fisheries in the near future (OECD/FAO, 2019). In Nigeria, the prominence of aquaculture as fish food source has kept growing over time while supply from capture fisheries is dwindling owing to undue fishing pressure and climate change among other factors (Olanrewaju, Kareem and Ajani, 2016).

The fish farming as an industry is faced with a lot of constraints which include inadequate supply of fishing inputs (fingerlings and feed), rising cost of trawling operation, insufficient production of fingerlings of cultivable fish species, lack of sufficient least cost-effective feed for fish culture among others (Oluwatayo and Adedeji, 2019; Olagunju, 2020). Nwuba and Aguigwo (2002) and Abayomi et al. (2010) stated that a prerequisite for a successful catfish enterprise is the regular availability and supply of fish seeds (fingerlings) of commercially important species and that fingerlings production through artificial propagation remains the only practicable means of producing enough quality fish seed. Scarcity of and/or shortfall in the supply of fingerlings, unavailability of fish feed, good market prices, land and water availability, diseases, law and supporting policies by concerned authorities are challenges to aquaculture production (Ansa, 2014; Olajide and Omonona, 2019; Adeleke et al., 2021).

Despite the economic, nutritional, and health benefits of fish to a man, the development of induced breeding with production systems and hatchery management techniques to sustain catfish production in the form of making catfish seed of good quality available to interested farmers (Pouomogne, 2008), the demand for fish has not been met (Emokaro et al., 2010). There have been reports of increasing withdrawal of farmers from fish farming in favor of other agricultural ventures. Some of the reasons attributed to this include poor quality of fish feed and seed and reduced profitability of fish farming (PIND, 2017; Digun-Aweto and Oladele, 2017). In Edo State, Nigeria, there seem to be attempts by some farmers who chose the specialty of catfish fingerlings production in the aquaculture value chain in a bid to have the farmers provided with fingerlings for sustained production all year round. Therefore, this study examined the socioeconomic characteristics of catfish fingerlings farmers, estimated the profitability and the profit efficiency of catfish fingerlings production, and identified the constraints to catfish fingerlings production in the Edo South agro-ecological zone of Edo State, Nigeria.

Materials and methods

Edo State, Nigeria lies roughly between longitude 05° 04’ and 06° 43’ east of the prime meridian and latitudes 05° 44’ and 07° 34’ north of the equator (Oladipupo, Egbenayabuwa and Sede, 2014). It shares boundaries with Delta State in the south, Ondo State in the west, Kogi and Anambra States in the east (Ahmadu and Emokaro, 2012). The state has a land area of about 19,794 km^2 and a population size of about 4,539,651 (Ebomwonyi, Omorogie, Noutcha, Abajue i Okiwelu, 2019). The main ethnic groups in the state are the Edos, Esans, Afemais, Owans, and Akoko-Edos. Edo State is divided into three agro-ecological zones (based on Edo State Agricultural Development Project – ADP Delineation), comprising Edo South, Edo Central, and Edo North agro-ecological zones. Edo South is made up of seven local government areas (LGAs). Edo Central has five LGAs, and Edo North has six LGAs making a total of 18 LGAs in Edo State. The seven LGAs in Edo South include: Egor, Ikpoba-okha, Oredo, Orionmwon, Ovia North-East, Ovia South-West, and Uhumwonde LGAs with their capital located in Uselu, Idogbo, Benin City, Abudu, Okada, Iguobazua, and Ehor, respectively. Edo State is characterized by a tropical climate, which ranges from humid to sub-humid at different times in the year. The three distinct vegetations identified in the state are the mangrove forest, freshwater swamp, and savannah vegetations. The mean annual rainfall in the northern part of the state is between 127-152 cm while the southern part of the state receives about 252-254 cm of rainfall annually, with average ranging from a minimum of 24°C to a maximum of about 33°C (Erhabor and Emokaro, 2007). The study area, Edo South agro-ecological zone has a land mass of about 10,900 km^2, a provisional population of about 1,719,725 (Ebomwonyi i in., 2019). It lies in the tropical rainforest belt between latitude 5.49°N-6.50°N and longitude 5.00°E-6.10°E (Osawaru and Daniel-Ogbe, 2012). The major occupation of the inhabitants of the study area aside the civil service is agriculture. Agricultural practices carried out in the area include arable and tree crops production, fishing, snailery, aquaculture, poultry and livestock rearing (Ahmadu and Ojogho, 2012). The study population consists of all catfish fingerlings producers in Edo South agro-ecological zone, Edo State, Nigeria. Edo South was purposively selected, because catfish farming business is prominent in this area.

Using structured questionnaires, 120 respondents was sampled based on a three stage sampling procedure adopted for the study. The first stage involved the selection of the three LGAs (Oredo, Ovia North East, and Egor) from the study area. The second stage involved the purposive selections of four communities from each of the LGAs selected while the third stage involved the random sampling of 10 farmers (10 farmers selected from four communities each producing catfish fingerling, which makes 40 farmers in a LGA. When this selection is replicated in the second and third LGAs, they make 120 respondents) producing catfish fingerlings in the selected communities. Descriptive statistics and inferential analytical tools were used to analyze data collected for this study. Descriptive statistics of frequency tables, percentage, and mean were used to examine the socio-economic characteristics of the respondents. Budgetary analysis was used to determine the profitability of the catfish production. Stochastic profit function was used to examine the profit efficiency of the catfish fingerlings production while Likert scale was used to profile the constraints to catfish fingerlings production in the area.

Budgetary analysis employs the gross margin (GM) and net profit (NP) analysis as adapted from Omotesho et al., (2012) and Obalola, Agboola, and Odum (2017). The gross margin (GM) is defined as:

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

where:
TR = total revenue from fingerlings production (NGN)
TVC = total variable cost (NGN)

Net profit is expressed as:

$$NP = TR – TC \qquad (2)$$

where:
TC = total cost
and TC = TFC + TVC
where
TFC = total Fixed Cost

The function of the stochastic profit frontier was used to determine the profit efficiency by testing the adequacy of the Cobb-Douglas (highly restrictive) by fitting it the less restrictive model.

The frontier model was adapted from Ugwumba and Chukwuji (2010); Tsue, Lawal, and Ayuba (2012); Ume et al. (2021), and is defined as follows:

$$\gamma_i = \beta_0 + \Sigma_i^8 = {}_1\beta_i X_i + V_i - U_i \qquad (1)$$

$$\gamma_i = \beta_0 + \Sigma_i^8 = 1\beta iXi + \Sigma_i^4 = 1\ \Sigma_i^4 = \beta ijXXji + V_i - U_i \qquad (2)$$

$$\mu i = \square_0 + \Sigma^0_d = 1_d \square_d Z_{di} + e_i \qquad (3)$$

where:
γ_i = Y = normalized profit (NGN)
X_1 = cost of seed (NGN)
X_2 = fertilizer cost (NGN)
X_3 = labor cost (NGN)
X_4 = transport cost (NGN)
X_5 = cost of feed (NGN)
X_6 = cost of medication (NGN)
X_7 = cost of electricity (NGN)
X_8 = depreciation (NGN)
e = stochastic error term
V_i = statistical distribution term
U_i = farmers' specific characteristic related to production inefficiency.

The explicit functional form of the stochastic profit function for the catfish fingerlings farmers in the study area is therefore specified as follows:

$$\gamma_i = Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + V_i - U_i \quad (4)$$

where:
$\beta_1 - \beta_8$ = coefficients to be estimated.

All other variables are defined as earlier.

As for the Likert scale method, a 5-point scale was adapted for elucidated responses which are grouped as:
very serious (VS) = 5
serious (S) = 4
moderately serious (MS) = 3*
least serious (LS) = 2
not serious (NS) = 1

*Cut off mean = 3

Results

Socio-economic characteristics of respondents

The socio-economic characteristics of respondents are presented in Table 1. From the presentation, catfish fingerling production is a male dominated activity. The modal age of respondents was between 21-40 years implying that producers of catfish fingerlings in the area are relatively young and in their productive years. About 45.8% were married with a modal household size of about 3-5 persons. This modal size is relatively small and will lead to shortage of household labor and increase cost for hired labor. About 87.5% had one form of education, 56.7% declared agriculture as their main occupation, and 43.3% engage in trading as their primary occupation. Of the 56.7% of respondents who had agriculture as their primary occupation, 53.3% were engaged full time as producers of catfish fingerlings with about 95.8% having 1-14 years of experience.

Table 1

Socio-economic characteristics of respondents

Variable	Frequency (=120)	Percentage (%)
Gender		
Female	45	37.5
Male	75	62.5
Age (years)		
≤20	15	12.5
21-40	55	45.8
41-60	35	29.2
≥60	15	15.5
Marital status		
Married	55	45.8
Single	35	29.2
Widowed/Separated/Divorced	30	25
Household size		
≤3	30	25
3-5	40	33.3
6-8	30	25
≥8	20	16.7
Educational qualification		
No formal qualification	15	12.5
Primary education	15	12.5
Secondary education	45	37.5
Tertiary Education	45	37.5
Occupation		
Farming	68	56.7
Trading	52	43.3
Nature of fish farming		
Full-time	56	46.7
Part-time	64	53.3
Number of years in the fingerlings production business		
≤5	45	37.5
6-10	60	50.0
10-14	10	8.3
≥15	5	4.2

Source: authors' field survey, 2016.

Information on catfish fingerlings production

Necessary information about fingerlings production is presented in Table 2. Presented results show that *Clarias gariepinus* was the dominant species of catfish used for fingerlings production. 58.3% purchased/constructed their own ponds for their production, 29.2% inherited theirs, while 4.2% had theirs donated as gift after undergoing some training for their activity. Their main source of finance was from their personal savings over time and 50% of respondents bought their feeds and medication from the open markets. 60% of labor used was hired. This has a potential of increasing cost of labor and reducing farm profit. The modal class for number of cycles of fingerlings produced annually was two principally because fingerlings producers were also into raising and marketing of table size fishes hence they need some time out to take care of their brooding stock. Tarpaulin ponds, plastic tanks, and concrete ponds scored 40.8%, 35%, and 24.2%, respectively, as the pond types used for catfish fingerlings production in the area.

Table 2

Production information

Variable	Frequency	Percentage (%)
Species of catfish produced		
Heterobranchus bidorsalis	36	30.0
Clarias gariepinus	64	53.3
Hybrid	20	16.7
Ownership of pond		
Inherited	35	29.2
Purchased/constructed	70	58.3
Rent	10	8.3
Donated as a gift	5	4.2
Source of finance		
Credit	9	9.0
Personal savings	88	88.0
Grants	3	3.0
Source of feed		
Open market	60	50.0
Agricultural Development Project Zone Office	33	27.5
Formulated feed	27	22.5
Source of medication		
Veterinary shop	39	32.5
Agricultural Development Project Zone Office	21	17.5
Open market	60	50.0
Source of labor		
Hired labor	72	60.0
Family labor	48	40.0

cont. Table 2

No. of annual production cycles carried out		
1	10	8.3
2	40	33.3
3	35	29.2
4	15	12.5
5	20	16.7
Rearing facilities used		
Concrete pond	29	24.2
Plastic tank	42	35
Tarpaulin pond	49	40.8

Source: field survey, 2016.

Costs and return of catfish fingerlings production

Table 3 shows costs and returns to catfish fingerlings production in a cycle by a producer in Edo South, Edo State, Nigeria (Table 3 is the summary of average return for one farmer out of the sampled 120 farmers).

Table 3

Cost and return of catfish fingerlings production per size of pond 28 m x 24 m (672 m^2)

Items	Average value/ production cycle (NGN)
Variable cost	
Breeding stock	454,342.5
Feed	53,994
Fertilizer	18,275
Medications	4,020.75
Water	11,343.75
Petrol (fuel)	44,138.5
Transportation	12,632.75
Repairs/services	9,858
Family labor	16,316
Hired labor	31,833.25
Total variable cost (TVC)	**656,754.5**
Fixed farm cost (depreciation)	
Pond	36,894.2
Pumping machine	25,027.63
PH meter	3,668.13
Secchi disc	3,359.25
Nets	4,200
Aerator	14,246.75

cont. Table 3

Drainage device	10,786.75
Bowls	1,620.25
Electricity	21,940.25
Catfish fries purchases	22,941.25
Total depreciation/Total fixed cost	**144,684.46**
Total cost	**801,438.96**
Revenue for 120,000 fingerling	**2,885,443.2**
Gross margin	**2,228,688.7**
Profit	**2,084,004.24**

Source: field survey, 2016.

From the results presented in Table 3, on the average, a catfish fingerlings producer incurs NGN 656,754.5 as their TVC and 144,684.46 as their TFC/depreciation per 120,000 fingerlings. The producer earns a revenue of 2,885,443.2. Consequently, the fingerlings producer makes 2,228,688.7 as their gross margin and 2,084,004.24 as net profit per production cycle. It is inferred that catfish fingerlings production is a profitable venture in the study area.

Profit efficiency estimation

Maximum likelihood estimate (MLE) of stochastic profit frontier of catfish fingerlings production is presented in Table 4. The result show that the co-efficient of labor cost (2.4455) among other estimated parameters of the normalized profit based on the assumption of competitive input and output market was positive except fixed cost (depreciation) and cost of transportation that was negative but all significant at 5% level of probability. Cost of labor was positive implying that a unit increase in the prices of labor cost would lead to increase in the normalized profit of catfish fingerlings production in the study area and this is in contrast with apriori expectation but in agreement with Zeynep (2009) who opined that the increase in profitability is due to conformance to and insistence on quality of a particular process for which complete value for cost of labor is gained and sufficiently subsumed in the profit such that profit is not significantly affected. Fixed cost (depreciation) and cost of transportation were negative implying that a unit decrease in fixed cost (depreciation) and cost of transportation would lead to an increase in the normalized profit of catfish fingerlings production in the study area and this is according to apriori expectation. Additionally, the estimated sigma square (δ^2) of 5.7212 was positive and significant at 5%, indicating a goodness of fit of the model while the estimated gamma of 0.3328 was also positive and significant at 5%, indicating that about 33.3% of the variation in the profit among the catfish fingerlings farmers were due to differences in pond size and practices rather than random variability.

Table 4

The maximum likelihood estimates (MLE) of profit efficiency of the catfish fingerlings production

	Coefficient	t-ratio
Constant	11.9790	13.1127[a]
Labor cost	0.1924	2.4455[a]
Fertilizer cost	0.0245	0.3555
Depreciation	-0.1298	-5.7873[a]
Cost of medication	-0.0422	-0.8945
Cost of seed	-0.0093	-0.1753
Transport cost	-0.0478	-2.9777[a]
Cost of electricity	-1.1921	-0.7249
Cost of feed	1.6961	1.0176
Sigma-squared	5.7212	9.3091[a]
Gamma	0.3328	3.3387[a]

[a] Significant at 5%

Source: field survey, 2016.

A. Profit efficiency range of catfish fingerlings production

The profit efficiency of catfish fingerlings farmers presented in Table 5 ranges from 0.2 to 1.0 with a mean efficiency value of 0.57. Therefore, an efficiency gap of 0.43 exists, indicating that catfish fingerlings producers were operating on a profit efficiency of 43% below the frontier. However about 70% of the catfish fingerlings producers were operating at a profit efficiency above the mean value which implied that most of the farmers were relatively efficient in profit making in the catfish fingerlings production business. The result further indicates that causes of inefficiencies should be considered and treated so as to enhance higher efficiencies by catfish fingerlings producers and hence operate at the optimum profit frontier.

Table 5

Distribution of efficiency range

Range	Frequency	Percentage
≤0.2	8	8
0.2-0.3	12	12
0.4-0.5	10	10
0.6-0.7	30	30
0.8-1.0	40	40
Total	100	100
Mean efficiency = 0.57		

Source: field survey, 2016.

B. Production constraints

The constraints faced by respondents are presented in Table 6. Any constraint having a mean above 3.0 is serious and poses a threat to catfish fingerlings production in the study area. Inadequate water supply (mean = 3.48), high cost of feed (mean = 3.46), high cost of transportation (mean = 3.25), and inadequate funds (mean = 3.21) in descending order rank as the major constraints faced by the respondents in the study area. Other constraints like pest and disease outbreak (mean = 2.78) are considered not to be a serious constraint faced by the catfish fingerlings farmers in the study area possibly because they have a solution to them due to practice overtime.

Table 6

Production constraints faced by respondents

Constraints	Mean	Standard deviation
Inadequate water supply	3.4825[a]	1.1027
High cost of feed	3.4575[a]	0.8551
Inadequate funds	3.2125[a]	1.0801
High cost of transportation	3.2500[a]	1.0952
Pest and disease outbreak	2.7775	1.2107

[a] Serious constraints (mean > 3.0)

Source: field survey, 2016.

Conclusions

Conclusively, catfish fingerlings production is a male dominated enterprise whose actors are relatively young with a modal age of 21-40 years, were predominantly married with 87.5% having one form of education or the other. About 56.7% of respondents took to catfish fingerlings production fulltime. *Clarias gariepinus* was the major type of catfish used for fingerling production and its production is done using different pond systems. Catfish fingerlings producer incurs NGN 656,754.5 as his TVC and 144,684.46 as his TFC/depreciation per 120,000 fingerlings. The producer earns a revenue of NGN 2,885, 443.2 makes NGN 2,228,688.7 as his gross margin and NGN 2,084, 004.24 as net profit per production cycle implying that catfish fingerlings production is a profitable venture in the study area. Labor cost, depreciation, and cost of transportation affected profit of fingerlings producers positively in that they led to increase in their normalized profit in their activity of catfish fingerlings production. On efficiency, about 70% of respondents were operating at a profit efficiency above the mean value indicating that most of the farmers were relatively efficient in profit making in the catfish fingerlings production business. Inadequate water supply, high feed and transportation costs, as well as inadequate funds respectively ranks in descending order as the main constraints to catfish fingerling production in the study area.

Aside the issues affecting profitability and constraints, catfish fingerlings production is relatively profitable in the area, although there is room for improvement by the producers along the profitability frontier. The study therefore recommends that catfish fingerlings producers organize themselves into cooperative groups to enable them pull resources together and even access some credits to put in place a water infrastructure to take care of inadequate water supply, participate in the price fixing process of feeds, partner with some logistics companies to gain some discounts in transportation. It is also recommended that the government, investors, and financial institutions provide some form of credits facilities to catfish fingerlings producers to support and sustain their production and make the venture sustainable in meeting with demands all year round.

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RENTOWNOŚĆ I EFEKTYWNOŚĆ DOCHODOWA PRODUKCJI NARYBKU SUMA W EDO SOUTH W NIGERII

Abstrakt

W badaniu wykorzystano statystyki opisowe, analizę budżetową i stochastyczną funkcję zysku w celu przeprowadzenia analizy danych zebranych od 120 producentów narybku suma w stanie Edo w Nigerii, mając na celu zbadanie opłacalności i efektywności jego produkcji. Wyniki badań pokazują, że produkcja narybku suma jest działalnością zdominowaną przez mężczyzn w wieku 21-40 lat, z których 53,3% zatrudnionych jest na pełny etat jako producenci narybków. Dominującym gatunkiem wykorzystywanym do produkcji narybku był Clarias gariepinus. Producenci zarabiają 2 885 443,20 NGN i osiągają 2 084 004,24 NGN zysku netto na cykl produkcyjny 120 000, co oznacza, że produkcja narybku suma jest dochodowym przedsięwzięciem na badanym obszarze. Koszty pracy, amortyzacja i koszty transportu wpłynęły pozytywnie na zyski producentów narybku, ponieważ doprowadziły do wzrostu ich znormalizowanego zysku. Około 70% producentów narybku suma działało powyżej średniej wartości wydajności, co oznacza, że większość hodowców była stosunkowo wydajna w osiąganiu zysków. Niewystarczające zaopatrzenie w wodę, koszty karmy, wysokie koszty transportu oraz niewystarczające środki finansowe były głównymi ograniczeniami, z jakimi borykali się respondenci na badanym obszarze. Epidemie szkodników i chorób nie były poważnymi ograniczeniami. W związku z tym badanie zaleca rozważenie i leczenie przyczyn nieefektywności w celu zwiększenia wydajności producentów narybku suma i działania na granicy optymalnego zysku. Zaleca się również zaproponowanie rozwiązań ograniczających produkcję narybku suma przez zainteresowane władze, aby przedsięwzięcie było zrównoważone i spełniało wymagania przez cały rok.

Słowa kluczowe: opłacalność, wydajność, *Clarias gariepinus*, narybek, produkcja, Edo South.

Submission date: 3.06.2021.
Final revision date: 1.07.2021.
Acceptance date: 1.10.2021.