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Full Length Research Paper

A comparative study of the profitability of brush parks in two states in Nigeria

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Brush parks consist of branches of trees or shrubs stuck into muddy bottoms of lagoons, lakes or rivers at a depth of 1 to 1.5 m. The branches are placed in water to form aggregations, which are removed after a short lapse of time, together with any fish that may have sought shelter amongst them. Brush parks are found in several of the West African coastal lagoons such as Lagos and freshwater environments in Niger State, Nigeria. The study examined the profitability of the brush parks in two states in Nigeria. Data was collected by means of semi-structured questionnaire administered to 200 fishermen with brush parks selected in a random manner from Niger and Lagos States of Nigeria. Independent samples t-test was used to compare the means of two independent samples for test of significance. Chi square (χ^2) was used to investigate the significant relationships between pairs of categorical variables. Relationships between pairs of quantitative variables were tested using Pearson correlation. The profitability indices showed that brush parks are profitable in the two states. The brush parks are more profitable in Lagos State because net return was significantly (p=0.001) higher in Lagos than Niger State. Rate of income (91%) and benefit-cost ratio (10.3) were also higher in Lagos than Niger State. Production of fish from brush parks should be supported and encouraged. Support could be in the form of technical assistance, infrastructure development, extension services or subsidies.

Key words: Nigeria, brush parks, Acadjas, profitability.

INTRODUCTION

Brush parks consist of branches of trees or shrubs stuck into muddy bottoms of lagoons, lakes or rivers at a depth of 1 to 1.5 m (Figure 1). Often, several types of branches are used, with the harder ones to surround and shape the structure and the softer elements to fill it. In some cases, such as the Lagos lagoon (Solarin and Udolisa, 1993), other materials such as old tyres and plastic pipes are used to supplement the fill. In the coastal lagoons of Benin Republic, many of the larger parks are filled with horizontal soft wood branches or woody debris (Welcomme, 1972) and in the Kaptai Lake of Bangladesh, materials such as floating aquatic weeds, water hyacinth (*Eichhornia crassipes*), *Enhydra fluctuans* and *Ipomoea aquatica* are used to provide shed for fishes while branches and roots of different trees like Hijal (*Barringtonia acuitangula*), mango (*Mangifera indica*), black-berry (*Syzygium cumini*) and Jack fruit (*Artocarpus integra*) are used for shelter (Uddin et al., 2015).

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(a) (b)

(c)

Figure 1. Types of brush parks in Niger and Lagos States. (a) Brush park constructed of branches of *Avicennia marina* in Lagos Lagoon; (b) Brush park constructed of palm fronds (*Elaies guineensis*) in Badagry creek, Lagos and (c) Brush park constructed of branches of *Mitragyna inermis* in an ox bow lake near Dangi village, Mokwa local government area of Niger State, Nigeria.

The branches are placed in water to form aggregations, which are removed after a short lapse of time, together with any fish that may have sought shelter amongst them. Installations of this type may be considered as refuge traps that exploit fish stock in the open waters in which they are placed, or which draw fish from the cover of adjacent reed-beds. In some coastal lagoons, however, the use of larger semi-permanent parks has been developed to a point where they give high yields, but at the same time may serve as sites for seed production for the surrounding waters (Welcomme, 2002). Brush parks offer a number of biological and economic advantages in the management of small scale fisheries in coastal lagoons, lakes and rivers and these include the stocking of open waters through “overflow” of fingerlings from brush parks, conservation of fishery resources and local

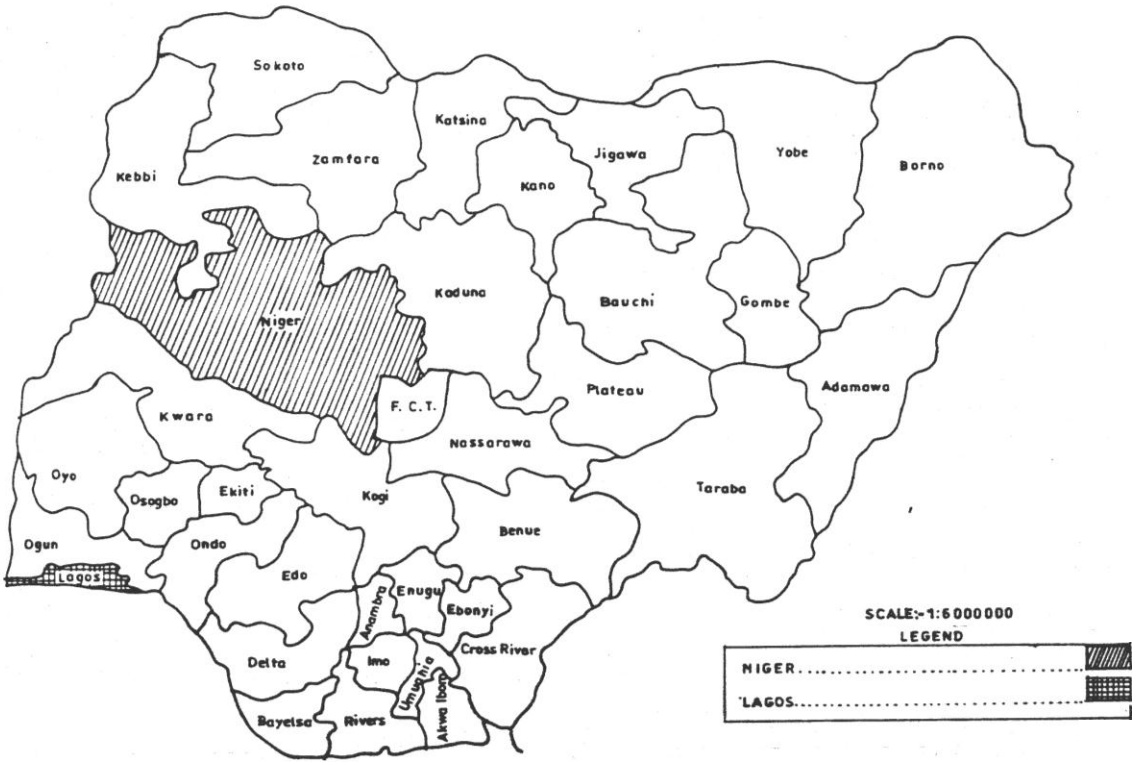

Figure 2. Map of Nigeria showing the study areas: Niger and Lagos States.

employment (Welcomme and Kapetsky, 1981; Hem and Avit, 1996).

Total cost is the amount of money that must be expended to obtain various levels of production and is often divided into explicit and implicit costs (Jolly and Clonts, 1993). The money payments for fertilizer, fingerlings and feed are explicit costs. Explicit costs also include payments for fixed assets and depreciation. Implicit costs are opportunity costs that are not often reflected in the farmer's accounting statement. The opportunity cost of resources used (such as land, labour and capital) should be included as cost items in the cost-return calculation especially in developing countries where labour use is intensive (Shang, 1990; Jolly and Clonts, 1993). In the present study, opportunity costs of own capital and family labour were included as cost items.

Total cost can be further categorised into fixed and variable costs. Fixed costs are those that must be paid by the farmer regardless of how much his farm produces. Fixed costs do not change in magnitude as the amount of output of the production process changes. These costs include land, property taxes, depreciation and interests on capital investments. Variable costs include payments for items such as feed, fingerlings, fertilizers and labour. Variable costs vary during the production period. In the study of aquaculture, much attention has been focused on bio-technical aspects. Economic research is often neglected by aquaculturists. Economic analysis is essential to evaluate the viability of investment in aquaculture, determine the efficiency of resource allocation, improve existing management practices, evaluate new culture technology, assess market potential, and identify areas in which fish production would have high payoffs (Shang, 1990). The primary motivation of a commercial fish farm is profit making. Although traditional brush park systems exist in Lagos lagoon and riverine fresh water environments of northern Nigeria (Reed et al., 1967; Solarin and Udolisa, 1993), there is little information on the costs and returns of brush parks in Nigeria. Hence, this study was undertaken to examine the profitability of brush parks in two states in Nigeria, Niger and Lagos.

MATERIALS AND METHODS

Two states with different eco-zones and cultural backgrounds were identified for the study: Niger, an inland state with a predominantly Muslim population, and Lagos, a coastal state with a predominantly Christian population (Figure 2). In each state, a random system was used for selecting fishermen. Data was collected by means of semi-structured questionnaire. The questionnaires were administered to

200 fishermen randomly selected from two states in Nigeria; Niger and Lagos. Data collected included size, productivity of the brush parks, amount spent on fishing nets and inputs such as feed. Information on the quantities of wood used per m^2, production cycle per year and installation period of brush parks before harvest was also solicited.

Interest on own capital was calculated from interest rate of commercial banks per annum. Opportunity cost of family labour was estimated from cost of hired labour in the area. Depreciation rate was estimated using the straight line method assuming a salvage value of zero at the end of useful component life. Annual depreciation rate was therefore computed by dividing the cost of the asset by its expected years of economic life (useful life). Fishing nets were the only items depreciated in this study. Profitability was defined by the following criteria:

1. Net return, defined as gross revenue minus total cost. The gross or total revenue is the total product or output multiplied by the market price of output. A positive net return means the activity is profitable.
2. Benefit-cost ratio, defined as net return divided by the total costs. A ratio of greater than 1.0 is thus the indication of profitable activity.
3. Rate of farm income, defined as net return divided by gross revenue times 100. The larger the rate of farm income, the greater the production efficiency.

Data was collected in December, 2014.

Statistical analysis

Data was analysed using Computer software package SPSS 16.0 for Windows (Statistical Package for Social Scientists). Independent samples t-test was used to compare the means of two independent samples for test of significance. Chi square (χ^2) was used to investigate the significant relationships between pairs of categorical variables. Relationships between pairs of quantitative variables were tested using Pearson correlation.

RESULTS

Costs of production from brush parks

Total cost of production per hectare from brush parks varied significantly ($p<0.001$) between states. Mean total costs of fish production from brush parks in Niger and Lagos States were ₦15,590 and ₦30,012 ha^{-1} yr^{-1}, respectively [Nigerian Currency is Naira (₦). 1 United State Dollar = 168 Nigerian Naira in December 2014] (Table 1). Depreciation was the major cost item in both states. Feed and interest were the lowest cost items in Niger and Lagos State, respectively.

Profitability of brush parks

Mean production of fish from brush parks in Niger and Lagos States were 403 and 756 kg ha^{-1} yr^{-1}, respectively (Table 2). There was a significant difference ($p = 0.001$) in the fish production from brush parks between the two states. Net return (₦310,188) was significantly ($p=0.001$) higher in Lagos than Niger State. Rate of income (91%) and benefit-cost ratio (10.3) were also higher in Lagos than Niger State. Average costs of fish production per kg from brush parks were ₦38 and ₦40 in Niger and Lagos States, respectively. Net return per kg was higher in Lagos than Niger State.

Quantities of wood used in brush park construction

Average number of branches used per m^2 in brush park construction in Niger was three compared with six for Lagos State. There was significant difference in the number of branches used per m^2 between the two states ($d.f. = 188$, $p < 0.001$).

Production cycle and installation period of brush parks before harvest

Production cycles of brush parks varied significantly ($\chi^2 = 18$, $d.f. = 2$, $p < 0.001$) between states (Table 3). About 70% of the fishermen in Niger constructed fish parks three times in a year as compared with 60% for Lagos State. Brush park installation period before harvest was significantly higher in Lagos than Niger state (Table 4).

Effect of density of branches and installation period on yield from brush parks

Fish yield from brush parks increased with number of branches used per m^2 (Figure 3). There was a significant ($r = 0.235$, $p = 0.001$) correlation between number of branches used and yield. There was also a significant ($r = 0.782$, $p < 0.001$) correlation between installation period of brush parks and yield (Figure 4).

DISCUSSION

Cost-return analysis is the basic method usually used to evaluate the economic viability or performance of a commercial aquaculture operation. This method is used to compare the economics of culture systems, different sizes of operation and farms in different locations (Shang, 1990). In the current study, costs and returns were found to vary with geographic location. Total cost of production from brush parks was significantly higher in Lagos than Niger State (Table 1). This could be due to high cost of inputs such as fishing nets leading to high depreciation in Lagos. Depreciation accounted for 44% of the total cost of production in Lagos State. Fishermen had larger brush parks in Lagos and hence needed larger nets to harvest fish from the brush parks. Brush park sizes were 0.07

Table 1. Costs of production from brush parks by state.

Cost item (₦ ha^{-1} year^{-1})	Niger	Lagos
Feed	1,420^{a} ± 14	4,362^{b} ± 44
Labour	5,120^{a} ± 14	10,100^{b} ± 71
Total variable cost	6,540^{a} ± 14	14,462^{b} ± 62
Interest	2,150^{a} ± 128	2,250^{b} ± 221
Depreciation	6,900^{a} ± 71	13,300^{b} ± 71
Total fixed cost	9,050^{a} ± 162	15,550^{b} ± 249
Total cost	15,590^{a} ± 177	30,012^{b} ± 265

Data are presented as mean ± standard deviation. Values with unlike superscript letters in a row differ significantly ($p < 0.05$) from each other. Nigerian Currency is Naira (₦). 1 United States Dollar = 168 Nigerian Naira in December 2014.

Table 2. Costs and returns of brush parks by state.

State	Niger	Lagos
	n = 100	n = 100
A. Mean production (kg ha^{-1} year^{-1})	403^{a} ± 25	756^{b} ± 56
B. Average price (₦ kg^{-1})	350*	450*
C. Gross revenue (₦ ha^{-1} year^{-1}) (A×B)	141,050^{a} ± 172	340,200^{b} ± 286
D. Mean total cost (₦ ha^{-1} year^{-1})	15,590^{a} ± 177	30,012^{b} ± 265
E. Net return (₦ ha^{-1} year^{-1}) (C- D)	125,460^{a} ± 247	310,188^{b} ± 390
F. Rate of income (%) (E/C × 100)	89^{a} ± 0.13	91^{b} ± 0.08
G. Benefit - cost ratio (E/D)	8.0^{a} ± 0.10	10.3^{b} ± 0.09
H. Average cost (₦ kg^{-1}) (D/A)	38^{a} ± 0.44	40^{b} ± 0.35
I. Net return (₦ kg^{-1}) (B - H)	312^{a} ± 0.44	410^{b} ± 0.35

Data are presented as mean ± standard deviation. Values with unlike superscript letters in a row differ significantly ($p < 0.05$) from each other. *Prevailing market price of fish.

Table 3. Brush park production cycles per year by state.

Production cycle	State	
	Niger (n = 100)	Lagos (n = 100)
Once	9(9)	31(31)
Twice	20(20)	8(8)
Thrice	70(70)	60(60)
Four times	1(1)	1(1)

Figures in brackets indicate percentages. Second and fourth rows were combined for the purpose of statistical analysis.

Table 4. Brush park installation duration by state.

State (n = 100)	Duration (months)
Niger	3.08 ± 2.36
Lagos	6.19 ± 3.13

Data are presented as mean ± standard deviation.

and 0.22 ha in Niger and Lagos State, respectively. In this study, fishermen fed their fish with local feeds such as corn bran and cassava wastes. Reed et al. (1967) also observed that few days before brush park is harvested, scraps of food, sometimes in baskets are placed amongst the branches. In the Indian vegetation parks feed consisting mainly of rice and rice bran is placed in bags hung below the vegetation mass. In Bangladesh, brush parks are fed with attractants such as rice bran, wheat bran, mustard oil cake and fermented rice (Welcomme, 2002; Uddin et al., 2015). Natural power of attraction of a brush park could be supplemented by feeding or by other attractions that draw more fish into the park, stop existing populations leaving thus fattening the fish that are resident in the park.

Net returns, rate of income and benefit cost-ratios were higher in Lagos despite the high cost of production as a result of higher production of fish from brush parks and market price per kg (Table 1). There is ready market in Lagos in which fish fetch higher price when compared

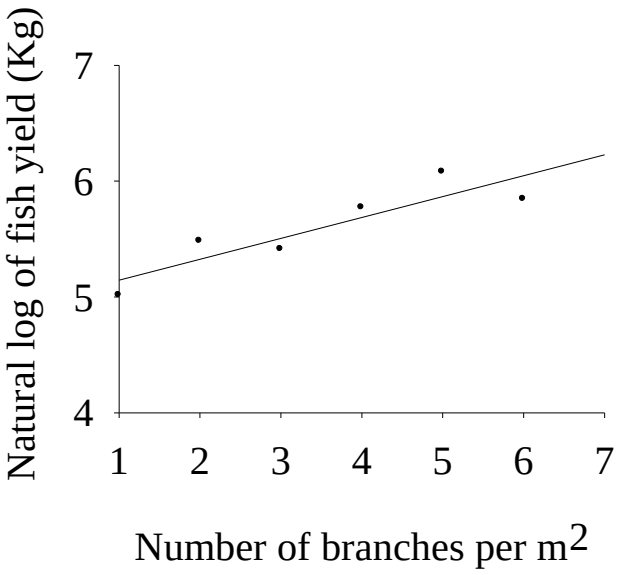

Figure 3. Effect of density of implantation on yield.

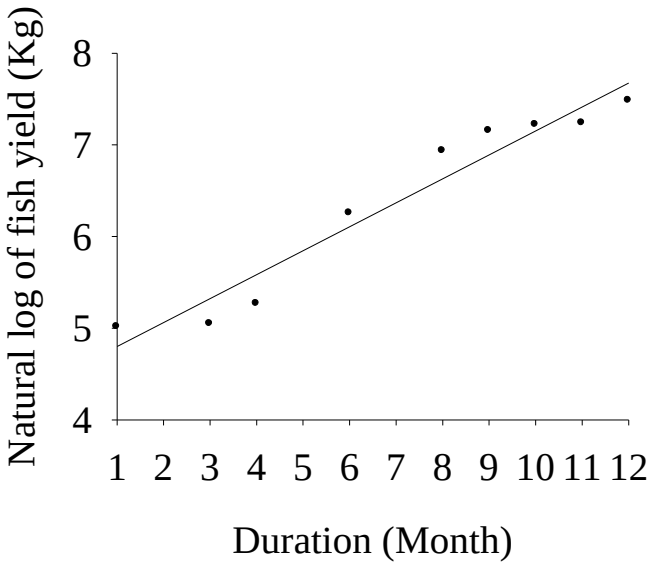

Figure 4. Effect of installation duration on fish yield.

with Niger State. Fish wholesalers in Niger State often transport smoked fish to Lagos as a result of better markets (DFID-FAO, 2002).

Higher productivity and net returns in Lagos State could also be due to higher quantities of wood used per m^2 and longer installation period of brush parks in Lagos. The main controllable variables influencing the yield and the economy of brush parks are the type of installation used, the density of brush used per unit area of brush park (Acadja), and the frequency of exploitation. Other factors include the species of fish present, the type of wood available, and its cost, together with the general productivity of the waters in which the Acadjas are installed (Welcomme, 1972; Anis et al., 2015). The greater the number of branches per unit area, the greater the catch (Welcomme, 1983). According to the author, yields rose from about 20 kg ha^{-1} at a planting density of 1 branch per m^2 to 20 t ha^{-1} at a density of 20 branches per $m^{2.}$

Profitability of a farm is dependent on level of yield, cost of production and farm price. The level of physical production is mainly dependent on stocking rate, survival rate and growth rate which are in turn affected by:

1. Bio-technical factors such as fertilisation and feeding, mono or poly-culture, different stocking and harvesting strategies,
2. Environmental factors such as water quality, diseases and predators, and
3. Physical facilities such as site selection, construction, soil condition and equipment used.

The cost of production relates to the level of input, the prices of inputs, the culture system, the size of operation, as well as the institutional factors such as costs of credit and marketing. The farm price of aquaculture products is usually affected by the size and quality of the product, the supply-demand situation for the product, the market structure and the existence (if any) of governmental pricing policies (Shang, 1990). Increases in yield, reductions in costs and increases in price, therefore are the major means of increasing profits.

Though brush parks can contribute to local deforestation and environmental degradation including siltation (Welcomme, 2002; Gomna, 2005), the present study has shown that they are profitable. Brush parks can also contribute to overall production of water body in which they are found by increasing reproduction, fry survival, cover for adults and, when properly managed, overall recruitment to the fishery in general. Besides improving productivity and thus food availability, the presence of periphyton on branches has a positive effect on water quality and the health of the system and the animals in it (Manissery et al., 2001; Shankar and Mohan, 2001) and thus sustainable.

Conclusion

The study revealed that brush parks are profitable in the study area as a result of positive net returns, high rate of incomes and benefit-cost ratios. The brush parks are more profitable in Lagos than in Niger State. Production of fish from brush parks should therefore be supported and encouraged. Support could be in the form of technical assistance, infrastructure development,

extension services, or subsidies.

Conflict of Interests

The author has not declared any conflict of interests.

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