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Profitability of Rice-Fish Farming in Bida, North Central Nigeria

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ABSTRACT

An experiment was conducted between August and November, 2008 at Wuya-Bida to determine the profitability of integrating fish culture into rice farming. Two treatments (mono-rice and rice-fish) in triplicate were used. The area of each plot was 144 m^2 and the mono-rice plots consisted of only rice farming while the rice-fish plots had rice farming incorporated with the raising of *Oreochromis niloticus* and *Clarias gariepinus* fingerlings. The fish were fed with compounded feed and wheat offal and at the end of the experimental period of 60 days, *O. niloticus* fingerlings had a mean weight gain of 47.60±1.86 g in the rice-fish plots while *C. gariepinus* fingerlings had a mean weight gain of 110.80±2.92 g. *C. gariepinus* fingerlings performed better than *O. niloticus* fingerlings. Values for physicochemical parameters showed that both pH and dissolved oxygen were outside the favourable limits (pH: 6.5-9, DO: >5 mg L^{-1}) recommended for warm water aquaculture in the rice-fish plots. Cost-benefit analysis showed that the integration of fish into the rice system confers substantial profitability on the system going from the production, total and net income differences between mono-rice and rice-fish plots. However, cost-benefit ratio of the mono-rice plots was slightly better than that of the rice-fish plots.

Key words: Mono-rice, rice-fish, *Oreochromis niloticus*, *Clarias gariepinus*, cost-benefit

INTRODUCTION

Poverty and malnutrition is a huge problem in Africa partly due to the lack of food security (Defoer *et al*., 2004). However, food security as well as poverty alleviation and socio-economic growth in Africa can be enhanced by the adoption of rice-fish farming which entails the growing of rice and fish concurrently or rotationally in the same compartments. It can also be done by growing of rice and fish in separate compartments, using the same water (Ahmed *et al*., 1992; Halwart and Gupta, 2004). In shallow water rice-fish farming, the water level is less than 50 cm while in deep water rice-fish farming, the water level is 50 cm and above. According to FAO (1993), the vast majority of the world's rice-fish farms are shallow water farms. Rice-fish farming is the most widely practised of all forms of integrated fish farming worldwide. Huge areas of land (especially in Asia) are used globally for rice-fish farming. According to Halwart (1998), the total rice farming area is about 148 million ha worldwide and about 90% of the world's rice farming area is in Asia. About 42.3 million ha of land is used for rice farming area in India while about 33 million ha is used in China. About 1.2 million ha of Chinese rice farming area is used for rice-fish farming. The major fish species cultured in Asian rice farms are the carps (common carp, grass carp, black carp etc.); *Tilapia* sp. (especially *O. niloticus*); silver barb and catfishes. In Africa, fishes usually cultured in rice fields are the *Tilapia* sp. (*O. niloticus* and *O. mossambicus*), *Clarias* and carp sp. In Egypt, fish production from rice-fish farming accounted for 32% of the total fish production from aquaculture in 1995 even though, rice-fish farming area declined from 224,917 ha in 1989 to

172,800 ha in 1995 due to the adoption of improved rice varieties and subsequent conversion of rice-fish areas to monoculture rice. In Madagascar, about 1,100 tons of fish were produced as at 1995 from about 13,500 ha of rice farms under FAO/UNDP assistance. Miller *et al.* (2006) concluded that since Nigeria has about 2 million hectares of irrigated and swampy rice areas, there's great potential for successful rice-fish farming. Okoye *et al.* (1999) carried out an experiment to compare yields from rice-fish farms in two ecological zones of Nigeria namely, Gwagwalada in the central zone and Dadin Kowa in the north-east zone. The experiment was done with a polyculture of *Clarias*, *Tilapia* and Common carp and the projected total income from the Gwagwalada area with a fish stocking density of 1,325 fingerlings was ₦60,710 while that of the Dadin Kowa area, with a stocking density of 1,700 fingerlings was ₦55,020. Culture period in Gwagwalada was 98 days and 105 days for Dadin Kowa. Yaro (1999) showed that stocking rice fields with fish at the rate of 1000-6000 fry ha^{-1} gave fish yield of 100-250 kg ha^{-1} with a net income of ₦10,800 ha^{-1}. Rice production gave a net income of ₦84,000. This shows that rice-fish farming has great potentials in Nigeria. In addition, Kogbe *et al.* (2000) and Yaro (2000) reported that rice yield from rice-fish culture was more than that from mono-rice culture. Halwart and Gupta (2004), concluded that rice-fish culture is likely to give higher rice yields than mono-rice culture because the rice-fish plots will have less weeds and pests since fish consume some of the weeds and pests. Wu (1995) concluded that excretion by fish adds nutrients to the soil and movement of fish enhances the circulation of nutrients in rice-fish culture leading to higher rice yield compared to mono-rice culture. This study was undertaken to determine the profitability of rice-fish farming in comparison to mono-rice farming in Bida, central Nigeria.

MATERIALS AND METHODS

Study area: The experiment was conducted at the rice farm of Edusoko and Sons Farm, Wuya-Bida, Niger State. The rice farm is basically rain fed but the experiment was done towards the end of the rainy season and this entailed the pumping of water from a nearby stream in order to maintain specific water levels. A rice nursery was made and rice seedlings were transplanted from it into the rice plots.

Preparation of mono-rice plots: Six plots (each of area 144 m^2) were used for the experiment consisting of two treatments (mono-rice and rice-fish) and two replicates. A rice nursery was prepared with FARO 52 rice variety (120 day maturity period) obtained from the National Cereals Research Institute, Badeggi. The mono-rice plots were prepared and bunds of height, 0.3 m were made around each rice plot. Herbicides were used to kill weeds and the plots were fertilized with Nitrogen, Phosphorus and Potassium (NPK) fertilizer (20:10:10) at a rate of 220 kg ha^{-1} and urea at a rate of 56 kg ha^{-1}. The 4-week-old seedlings were transplanted into the plots at a spacing of 20 cm between rows and lines. The rice plots were then flooded after the seedlings were transplanted. The water level was maintained at a minimum of 10 cm throughout the experimental period. The plots were weeded as the need arose and pesticides were also used to kill pests like stem borers, leafhoppers, snails etc.

Preparation of rice-fish plots: The rice-fish plots were also prepared and two trenches (each of dimension: 12×1×0.5 m) were dug opposite one another at the periphery of each plot. The trenches were dug in order to provide a place of deeper refuge for the fish when water level is to shallow for them. Bunds of height 0.6 m were made around each rice-fish plot. The rice-fish plots were fertilized with NPK and urea at the same rate as the mono-rice plots and seedlings were transplanted into them. The rice-fish plots were flooded with water after the seedlings were transplanted and the water level was maintained at a minimum of 20 cm throughout the experiment. Weeding of the plots was done adequately. No herbicide or pesticide was used in the rice-fish plots.

Stocking of fish: Fish was stocked into the rice-fish plots 35 days after transplanting at a density of 2 fingerlings m^{-2} as recommended by Onuoha (2006). Two hundred *Oreochromis niloticus* fingerlings (mean initial weight 3.9±0.17 g) and 100 *Clarias gariepinus* fingerlings (mean initial weight 2.2±0.25 g) were stocked into each rice-fish plot at a stocking ratio of 2:1. The fingerlings were fed compounded feed of 40% crude protein content in the morning and with wheat offal in the evening everyday.

Sampling of rice-fish plots: The pH, temperature, dissolved oxygen and conductivity of water in the flooded rice plots were measured before the fish were stocked. The plots were sampled weekly and this involved the measuring of the weights, total and standard lengths of fish; pH, temperature, dissolved oxygen and conductivity of water. Temperature and DO were measured with HACH dissolved oxygen meter (model DO 175); pH with Jenway pH meter and Conductivity with ELE conductivity meter (model DA-1). No pesticide was applied on the rice-fish plots.

Harvesting of rice and fish: The period from the planting of the rice seeds through transplanting to maturity was 123 days. The rice seedlings were transplanted 28 days after the nursery was made and the fish was stocked 35 days after the rice seedlings were transplanted and the fish spent 60 days in the rice-fish plots. The rice was harvested from the mono-rice plots and rice yield determined. The rice, followed by the fish, was also harvested from the rice-fish plots and yields of both rice and fish were determined and this was used to determine the viability of the rice-fish system.

RESULTS AND DISCUSSION

Fish production: The mean growth parameters of fish in the rice-fish plots are shown in Table 1. *O. niloticus* fingerlings in the rice-fish plots grew from an initial weight of 3.9±0.17 g to 51.50±1.77 g i.e., a weight gain of 47.60±1.86 g in 60 days. *C. gariepinus* fingerlings in the rice-fish plots had a mean weight gain of 110.80±0.92 g. The same profile is observed in mean values for total and standard lengths viz., *C. gariepinus* fingerlings performed better than *O. niloticus* fingerlings. This may be due to the fact that during feeding, *C. gariepinus* fingerlings out-competed *O. niloticus* fingerlings in picking the compounded feed. *O. niloticus* were only able to feed on wheat offal which by its nature, spreads all over the water surface. *O. niloticus* had already started breeding in the plots which means they had grown into breeders. No fish mortality was recorded throughout the experiment.

Table 1: Growth parameters of fish in the rice-fish plots

Parameter	*O. niloticus*	*C. gariepinus*
Mean initial weight (g)	3.90±0.17	2.20±0.25
Mean final weight (g)	51.50±1.77	113.00±1.22
Mean weight gain (g)	47.60±1.86	110.80±2.92
Daily weight gain (g)	0.79±0.00	1.85±0.00
Mean initial total length (cm)	7.00±0.20	9.80±0.50
Mean final total length (cm)	24.20±0.15	40.70±0.75
Mean initial standard length (cm)	4.85±0.20	7.70±0.35
Mean final standard length (cm)	20.46±1.00	35.90±0.80

Single factor ANOVA showed no significant difference ($p>0.05$) in the mean values of all the parameters in the replicates for both *O. niloticus* and *C. gariepinus*. But the mean values for the same parameters for *O. niloticus* were significantly different ($p<0.05$) from those of *C. gariepinus*. values of physicochemical parameters are shown on Table 2. Temperature ranged from 33.5 to 30.1°C. DO values in the rice-fish plots were lower than the 5-15 mg L^{-1} range recommended for good growth and reproduction of fish (Boyd, 1998). This may be responsible for the lower-than-expected growth of the fish. The DO of the stream water used to maintain the water level in the two plots was 4.34 mg L^{-1}. Conductivity ranged from 60-70 µS cm^{-1} while pH was lower than the 6.5-9 range recommended for warm water aquaculture (ASA, 1999).

Rice production: Production from the three mono-rice and three rice-fish plots are shown in Table 3. The mono rice plots produced more rice than the rice-fish plots and this is probably due to

Table 2: Mean values of physicochemical parameters

	Temperature (°C)	Dissolved oxygen (mg L^{-1})	Conductivity (µS cm^{-1})	pH
Initial	33.5	3.46	60	6.20
Final	30.1	3.16	70	5.89

Table 3: Production and cost-benefit analysis of mono-rice and rice-fish production (after 123 days for rice and 60 days for fish)

Item	Mono-rice	Rice-fish
Income		
Rice	78 kg×₦100 kg^{-1} = ₦7,800	60.5 kg×₦100 kg^{-1} = 6,500
Fish		
O. niloticus		30.9 kg^{-1}×₦200 kg = 6,180
C. gariepinus		37.24 kg×₦350 kg^{-1} = ₦14,896
Total income	₦7,800	₦27,576
Expenditure		
Labour		
Land preparation	900	900
Digging of trenches		600
Planting/transplanting	300	300
Fertilizing	300	300
Weeding	1,000	1,500
Rice harvesting	500	500
Rice milling	300	300
Inputs		
Rice seed	200	200
Fertilizer	600	480
Herbicide	450	
Petrol for water pump	500	1,000
Fish feed		7,900
Fish fingerlings		
O. niloticus 600 fingerlings×₦5		3,000
C. gariepinus 300 fingerlings×₦10	₦5, 050	3,000 ₦19,980
Total expenditure		
Cost-benefit ratio	1:1.5	1:1.4
Net income: A-B	₦2,750	₦7,596

the fact that they had more area for rice growth than the rice-fish plots which had part of their area used for rearing fish. The cost-benefit analysis of mono-rice and rice-fish sections of the experiment is also shown in Table 3.

It is obvious from Table 3 that rice-fish farming is a potentially profitable enterprise and will provide both carbohydrate and protein to the ordinary fish farmer in addition to making available more income for his needs. Table 3 shows that the integration of fish into the rice system confers substantial profitability on the system going from the total and net income differences between mono-rice and rice-fish plots. However, the experiment failed to achieve the higher rice yields in the rice-fish plots as stated by Kogbe *et al.* (2000) and Yaro (2000). While rice yield from the mono-rice plots was 78 kg, that from the rice-fish plots was 60.5 kg. In addition, the cost-benefit ratio of the mono-rice plots was slightly better than that of the rice-fish plots.

CONCLUSION AND RECOMMENDATIONS

The results of the experiment shows that rice-fish farming is more profitable than mono-rice farming and that in a situation where rice production fails, a farmer can minimise the loss he would have incurred from the production of fish. However, the experiment failed to achieve the expected higher rice yield from the rice-fish plots compared to the mono-rice plots and it is recommended that further studies be carried out to determine why this is so.

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