Agricultural Journal 5 (3): 229-233, 2010
ISSN: 1816-9155
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Environmental Sustainability and Profitability of Integrated Fish cum Crop Farming in Anambra State, Nigeria

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Abstract: The study examined the profitability of integrated fish cum crop farming and effects of socio-economic and demographic factors on farm income realized from it. Data were collected by means of structured questionnaire recovered from 80 farmers. Analyses of data were accomplished using descriptive statistics, farm budgeting technique, profit function and multiple regression. Profitability indicators using gross margin, net farm income and net return on investment portrayed the compared enterprises as profitable. Net return on investment for fish cum crop integration that utilized waste from the fish pond as organic manure in crop farm (1.21) was 0.5 higher than that of the alternative (1.16). The price parameters for fish feeds and output significantly accounted for more of the maximum variable profit in profit function analysis. Farm income was significantly influenced by years of experience, educational level and utilization of fish pond waste as organic manure in crop farm. Policy measures geared towards reduction in cost of inputs, favorable output price, enhanced farmer's knowledge and adoption of modern technologies would lead to bigger farm income.

Key words: Profitability, fish pond waste use, integrated fish cum crop farming, profit function, educational level, multiple regression

INTRODUCTION

Integrated farming (or integrated agriculture) is a commonly and broadly used word to explain a more integrated approach to farming as compared to existing monoculture approaches. It refers to agricultural system that integrate livestock and crop production. The inclusion of aquaculture especially fish farming, agro-industries and biogas production have been stressed by Olele *et al*. (1999) and Chan (2006) as make-ups for complete integration.

According to Chan (2006), the Integrated Farming System (IFS) has revolutionized conventional farming of livestock, aquaculture, horticulture, agro-industry and allied activities in some countries especially in tropical and subtropical regions that are not arid. Farming all over the world is not very performing unless relatively big inputs are added to sustain yields and very often compromise the economic viability as well as the ecological sustainability. IFS can remove all the farming constraints including shortage and high cost of inputs and environmental pollution. This could be done by not only solving most of the existing economic and environmental problems but also provides the needed means of production such as fuels, fertilizers and feed, besides increasing productivity many fold (Chan, 2006). The benefits of integrated farming system are enormous and encompass those of traditional farming system (Ugwumba and Orji, 2006) and modern farming system (Igbinnosa, 2006). As described by Tokrishna (2006), IFS reduces cost of production and thus increases farmer's productivity, income, nutrition and welfares. If properly adopted with investment in agriculture IFS improves the personal savings and health of farmers. Othman (2006) summarized the multifaceted benefits of IFS to include economics benefits in terms of increased food production, social function in terms of provision of employment opportunities for excess labour force displaced from other sectors in the urban areas. Integrated farming system can be complete integration involving crops, livestock, fisheries, biogas, agro-industry and allied activities (Chan, 2006) or partial integration made up of different combinations of the later units (Thy, 2006; Igbinnosa and Okporie, 2007). Various types of partial integration are practised by farmers in the study area and one of them is fish cum crop integration. Farm income from this farming system is poor due to high cost of inputs, traditional techniques among other problems. This study specifically sets to:

- Describe the socio-economic and demographic characteristics of integrated fish cum crop farmers
- Determine the profitability of integrated fish cum crop farming in the study area

- Access the effects of socio-economic and demographic factors on farm income realized from integrated fish cum crop farming

MATERIALS AND METHODS

The study area is Anambra state. It is one of the five Eastern States of Nigeria. It is comprised of 21 Local Government Areas (LGAs) and four agricultural zones. The latest population census conducted in Nigeria in 2006 estimated the population to over 4 million (Federal Republic of Nigeria, 2006). It occupies an area of 4,416 km^2, 70% of which is arable land which is under cultivation. The state is situated on a fairly flat land with tropical vegetation. The climate is humid with substantial rainfall and mean temperature of 87°. It has a weak soil that is easily eroded, thus accounting for over 500 erosion sites of varying depth and length (Anambra State Economic Empowerment Development Strategy (SEEDS), 2006). Agriculture is the predominant occupation in the rural areas engaging >70% of the rural population. Crop and livestock farming are traditional while fish farming is gaining grounds (Ugwumba, 2005).

A multistage random sampling technique was adopted to select 80 respondents for the study. The first stage involved picking one LGA from each of the 4 agricultural zones in the state. In stage 2, a random sampling of 2 communities was made in each of the 4 LGAs to produce 8 communities used in the survey. The final stage involved selection of 10 catfish cum crop farmers in each of the 8 communities by random sampling. In all, 80 interview instruments were distributed to the respondents, out of which 76 were returned.

Data collections for the study were mostly through primary sources. However, secondary sources of data were explored from relevant publications where necessary. Primary source of data comprised of the use of structured questionnaire items administered to the farmers. The questionnaires were administered with the assistance of trained enumerators at a point in time (i.e., cross-sectional data). Primary data collected included socio-economic and demographic characteristics of the respondents such as age, educational level, gender, family size, years of experience and utilization of waste in water from fish pond. Primary data were also collected on quantities of farm inputs and output and their current market prices. Non-parametric statistics (means, frequencies and percentages) were used to analyze the socio-economic and demographic characteristics of the farmers. Farm budgeting technique involving gross margin and net farm income analysis was employed in order to assess the profitability of the system. Further analysis of profitability was done using the profit function while multiple regression analysis derived from Lucey (2004) became the instrument used to ascertain the effect of socio-economic and demographic factors on income realized from the fish cum crop integration.

Gross margin in the difference between gross income (total revenue) earned and the total variable cost incurred (Ebe, 2007). Net farm income (profit) on the other hand is the difference between gross margin and total fixed cost. Both methods are shown as:

$$GM = TR\text{-}TVC$$

and

$$NFI = GM\text{-}TFC$$

Where:

GM = Gross Margin
TR = Total Revenue
TVC = Total Variable Cost
NFI = Net Farm Income
TFC = Total Fixed Cost

The profit function was used to further estimate profitability of the integrated farming system, this time the profitability levels of individual resource inputs on catfish cum crop enterprises. These inputs include variable and fixed capital items deployed by the enterprises in producing the various products. The profit function as specified by Sankhayan (1998) is shown as:

$$\Pi^* = \Pi^* (P_Y, P_1, P_2, P_3, P_4; Z_1, Z_2, Z_3)$$

Where:

Π^* = Amount of maximum variable profit (₦)
P_y = Per unit price of output (₦)
P_1 = Per unit price of planting materials (₦)
P_2 = Per unit price of catfish feed (₦)
P_3 = Per unit price of catfish seed (₦)
P_4 = Per unit price of labour (₦)
Z_1 = Value of farm land
Z_2 = Value of tools and equipment
Z_3 = Value of fish pond, livestock pen (₦)

Z_1, Z_2 and Z_3 are fixed cost items. They are therefore not included in the analysis since the analysis is bases on the short-run effect of input prices. The multiple regression used to achieve objective 3 is specified implicitly as:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6)$$

and explicitly as:

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + e$$

Where:

Y	=	Farm income
β_0	=	Intercept (the conditional mean of Y)
β_1-β_5	=	Regression coefficients
X_1	=	Farmer's age (years)
X_2	=	Farmer's experience (years)
X_3	=	Farmer's household size (number)
X_4	=	Farmer's educational level (years)
X_5	=	Utilization of fish pond waste (Dummy: utilized waste = 1, otherwise = 0)
X_6	=	Gender (Dummy: male = 1, female = 0)
e	=	Random or stochastic error

RESULTS AND DISCUSSION

Socio-economic and demographic characteristics of respondents: Socio-economic and demographic characteristics considered in the study includes age, years experience, household size, educational level, utilization of waste in water from catfish farm and gender. Table 1 shows results of analysis of the afore-mentioned variables by means of non-parametric techniques.

Majority of the farmers 85.6% fell within the active energetic age bracket of 31-60 years. This implies that catfish farming like other agriculture and agro-allied production activities (e.g., fuel word production sited by Ijana, 2000) requires youths that are full of energy who can comfortable handle such high energy demanding activities. Education and years of experience positively influence choice of business adoption of new ideas as well as management of business (Ebo, 2007). About 93.4% of the farmers attained various degrees of formal education while 81.6% had above 5 years of experience in the business.

This implies that catfish farming in the study area is run by experienced people expected to be working with new and sound ideas (curtsey of their education level) that would improve their productivity. The study also shows that most of the farmers were males 85.5 and the remaining 14.5% females. Again, household size of 6-10 was in the majority 47.4%, followed by 39.5% of 0-5 size. This depicts the availability of enough hands to contribute to labour demands of catfish farming activities. About 27.6% of the farmers dispose waste in water from their catfish pond into available drains. Those of them who utilized waste from their ponds to fertilizer their crop farms 72.4% profited from the act through cost minimization and consequent realization of increased output and thus income. Some of the farmers 32.9% utilized waste in water during the dry season for irrigating their crop farms but discharge some into drains in the raining season.

Table 1: Distribution of catfish farmers according to socio-economic and demographic characteristics

Variable	Frequency (N = 76)	Percentage (%)
Age		
<30	6	8.0
31-40	20	26.3
41-50	25	32.9
51-60	20	26.3
Above 60	5	6.6
Years of experience		
1-5	14	18.4
6-10	32	42.1
Above 10	30	39.5
Household size		
0-5	30	39.5
6-10	36	47.4
Above 10	10	10.2
Educational level		
No formal education	5	6.6
Primary	10	10.6
Secondary	28	36.8
Tertiary	30	39.5
Others	3	3.9
Utilization of waste in water		
Used as manure for crops	30	39.5
Disposed into drains	21	27.6
Use both methods	25	32.9
Gender		
Male	65	85.5
Female	11	14.5

Field survey, 2008

Profitability of integrated fish cum crop farming: Profitable assessment was performed using gross margin and net income for profitability in terms of sales and net returns on investment for profitability in relation to investment. While, the profit function analysis was used to assess the profitability of individual resource inputs on maximum variable profit.

Gross margin, net farm income and net return on investment: The estimated comparative profitability for enterprise that utilized waste in water from the fish pond for crop production (enterprise A) and enterprise that did not (enterprise B) are shown in Table 2. The respective gross margins for enterprises A and B were (₦) 1,587,500 and (₦) 1,548,500; net farm income (₦) 1,582,000 and (₦) 1,542,500; net return on investment, 1.21 and 1.16. These figures confirm the profitability of integrated fish cum crop enterprises as similarly posited by Olele *et al.* (1999) and Chan (2006). The net return on investment values of 1.21 and 1.16 for enterprises A and B, respectively imply that the farms realized profits of 121 and 116 kobo for every 100 kobo invested in fish cum crop farming. The difference of 5 kobo (i.e., 121-116) made by A over B per 100 kobo spent resulted from cost minimization due to the utilization of waste in water from the fish pond as organic manure for the crops. This means that utilization of fish pond waste as organic manure is cost saving, profitable and environmentally friendly (Garg *et al.*, 2007). This is

Table 2: Farm budget technique and return on investment

Items	Qty/ha/enterprise	Price/unit (₦)	Revenue/cost (₦) (A) fish-crop (utilize waste)	(B) fish-crop (utilize fertilizer)
Revenue				
Yam	1,500 tubers	200	300,000	300,000
Maize	2,000 kg	150	300,000	300,000
Cassava	15,000 kg	15	225,000	225,000
Vegetables	500 kg	100	50,000	50,000
Fish (live-catfish)	5,000 kg	400	2,000,000	2,000,000
Total Revenue (TR)	-	-	2,875,000	2,875,000
Variable cost				
Yam sets	1,200	80	96,000	96,000
Maize seeds	40 kg	150	6,000	6,000
Cassava cutting	30 bundles	200	6,000	6,000
Vegetable seeds	25 kg	100	2,500	2,500
Labour (crops)	-	-	50,000	50,000
Fertilizer (crops)	13 bags	3,000	-	39,000
Catfish seeds	5,200	10	52,000	52,000
Catfish seeds	7,000	150	1,050,000	1,050,000
Labour (fish)	-	-	15,000	15,000
Miscellaneous	-	-	10,000	10,000
Total Variable Cost (TVC)	-	-	1,287,500	1,376,500
Gross Margin (GM = TR - TVC)	-	-	1,587,500	1,542,500
Fixed Cost (FC)				
Crop farm	-	-	500	500
Catfish farm	-	-	5,000	5,000
Total Fixed Cost (TFC)	-	-	5,500	5,500
Total cost (TFC + TVC)	-	-	1,298,500	1,332,000
Net Farm Income (NFI = GM - TFC)	-	-	1,582,000	1,542,500
Net Return on Investment (NRI = NFI/TC)	-	-	1.21	1.16

Field survey, 2008, (₦) 150 = 1 US$

contrary to the practice of channeling it into drains from where it serves as source of bad odor for air pollution and as breeding ground for mosquitoes.

The profit function analysis: Table 3 profiles the effects of prices of output and individual variable inputs on maximum variable profit. The overall significance of the linear relationship between the dependent and independent variables is shown by the high F-statistic value of 59.472 at 10% level of probability. Also the combined effect of the variable price items in the function (R^2 = 0.841) explained about 84% of the variation in maximum variable profit. The t-statistic shows that the price parameters for fish feeds and output have significant effect on profit while the effects of those of labour, planting material, catfish seeds and waste in water from fish pond were insignificant. This implies that high output price and low feed price enhance farmer's income and profit. The farmers are therefore operating in the rational area of profit function; using all the variable price items.

Table 3: Estimated result of profit function analysis

Parameters	Coefficient	Standard error	t-value
Price of output	4.071	0.092	15.6540**
Price of labour	-6.551	0.041	0.0310
Price of fish feeds	-7.163	0.089	3.1440**
Price of planting materials	2.184	0.036	0.0080
Price of catfish seeds	3.711	0.045	0.0120
Price of fish pond waste	-2.123	0.048	0.0040
Intercept	-1.697	0.417	0.0003
R^2	0.841	-	-
F-statistic	59.472*	-	-

Field survey data, 2008; *Significant at 10% level of probability; **Significant at 5% level of probability

Effect of socio-economic and demographic factors on integrated fish cum crop farming: The result of multiple regression analysis of effects of farmer's age, years of experience, household size, educational level, gender and utilization of fish pond waste is shown in Table 4. The model adopted is a good fit. This is because 69% of total variation in farm income is explained by the independent variables. Also, the F-statistics figure of 27.126 further confirms the significant of this relationship.

The coefficients of years of experience, educational level and utilization of fish pond waste in crop farming are positively signed as expected. This implies that farmers who are educated have more years of experience and utilize waste in water from fish pond as organic manure for their crops tend to be more efficient in production and consequently will realize more income. The coefficients of household size and gender are negatively correlated with

Table 4: Estimated result of multiple regression analysis

Independent variables	Coefficients	t-values
Constant	128.412	7.562**
Farmer's age	3.715	0.314
Years of experience	1.267	2.453**
Household size	-0.130	-0.763
Educational level	7.814	4.621**
Gender	-2.223	-0.014
Utilization of fish pond waste	0.986	1.562**
R^2	0.694	-
F-statistics	27.126	-

Field survey, 2008; *Significant at 5%; **Significant at 1%

farm income and are insignificant. This means that integrated catfish cum crop farming depends less on the family labour but on hired labour. It is equally not gender biased. The older the farmer the more income he makes from the business. This could be attributed to years of accumulated experience and resources to invest in farming. However, farmer's age insignificantly determined income in this integrated system.

CONCLUSION

The study highlighted profitability and effects of socio-economic and demographic factors on integrated fish cum crop farming. Most of the farmers utilized waste from fish ponds as organic manure in crop farms there by saving costs that would have been expended on artificial fertilizers. This practice facilitated environmental sustainability, reduction in incidences of malaria disease and better profit. Farm income was positively influenced by farmer's age, years of experience, educational attainment and utilization of fish pond waste as organic manure. It was however, negatively related to household size and gender.

Policy must be tailored in favour of measures geared towards reduction in costs of inputs; improvement in price of output; enhancing farmer's knowledge and adoption of modern technologies. Such measures are deeply rooted in the provision of more infrastructural facilities and extension services that will encourage faster flow of goods, services, knowledge and information.

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