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 Tokrisina (2006), IFS reduces cost of production and thus increases farmer’s productivity, income, nutrition and walfares. If properly adopted with investment in agriculture IFS improves the personal savings and health of farmers. Ottuman (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 km², 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°F. 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:

$$GM = TR - TVC$$

and

$$NFI = GM - TFC$$

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:

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

Where:

- **$\Pi^*$**: Amount of maximum variable profit (₦)
- **$P_1$**: Per unit price of output (₦)
- **$P_2$**: Per unit price of planting materials (₦)
- **$P_3$**: Per unit price of catfish feed (₦)
- **$P_4$**: Per unit price of catfish seed (₦)
- **$Z_1$**: 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:

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \epsilon$$
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 wood 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 (curtesy 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>
<thead>
<tr>
<th>Variable</th>
<th>Frequency (N = 76)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;30</td>
<td>6</td>
<td>8.0</td>
</tr>
<tr>
<td>31-40</td>
<td>20</td>
<td>26.3</td>
</tr>
<tr>
<td>41-50</td>
<td>25</td>
<td>32.9</td>
</tr>
<tr>
<td>51-60</td>
<td>20</td>
<td>26.3</td>
</tr>
<tr>
<td>Above 60</td>
<td>5</td>
<td>6.6</td>
</tr>
<tr>
<td>Years of experience</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-5</td>
<td>14</td>
<td>18.4</td>
</tr>
<tr>
<td>6-10</td>
<td>32</td>
<td>42.1</td>
</tr>
<tr>
<td>Above 10</td>
<td>30</td>
<td>39.5</td>
</tr>
<tr>
<td>Household size</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-5</td>
<td>30</td>
<td>39.5</td>
</tr>
<tr>
<td>6-10</td>
<td>36</td>
<td>47.4</td>
</tr>
<tr>
<td>Above 10</td>
<td>10</td>
<td>10.2</td>
</tr>
<tr>
<td>Educational level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No formal education</td>
<td>5</td>
<td>6.6</td>
</tr>
<tr>
<td>Primary</td>
<td>10</td>
<td>10.6</td>
</tr>
<tr>
<td>Secondary</td>
<td>28</td>
<td>36.8</td>
</tr>
<tr>
<td>Tertiary</td>
<td>30</td>
<td>39.5</td>
</tr>
<tr>
<td>Others</td>
<td>3</td>
<td>3.9</td>
</tr>
<tr>
<td>Utilization of waste in water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Used as manure for crops</td>
<td>30</td>
<td>39.5</td>
</tr>
<tr>
<td>Disposed into drains</td>
<td>21</td>
<td>27.6</td>
</tr>
<tr>
<td>Use both methods</td>
<td>25</td>
<td>32.9</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>65</td>
<td>85.5</td>
</tr>
<tr>
<td>Female</td>
<td>11</td>
<td>14.5</td>
</tr>
</tbody>
</table>

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 Clele 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

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

Field survey, 2008, (₦) 150 = 1 US$

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 (R² = 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.

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 organ 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...
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.

**REFERENCES**