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Efficiency of Resource-use and Marginal Productivities in Dry Season Amaranth Production in Edo South, Nigeria

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Abstract: The objective of the study was to determine whether the resources employed in the production process were efficiently utilized. The primary data used in the study were gathered with the help of a well structured questionnaire, administered through the cost-route method of data collection. The simple random sampling technique was adopted after the study area had been stratified into regions where dry season amaranth production is carried out. The underlying analytical techniques employed were multiple regression analysis and descriptive statistics. The result showed that dry season amaranth producers in Edo South are smallholder farmers, predominantly males, with mean farm sizes ranging between 0.046, 0.067 and 0.093 hectare. It was also shown in the study that none of the resources employed in the production process was efficiently utilized. While land and fertilizer were underutilized (with efficiency estimate of 5.57 and 1.78, respectively), labour was shown to be over-utilized (with an efficiency estimate of 0.27). The immediate implication of these findings is that there is enough potential for increased production of amaranth, especially in the dry season when amaranth is known to be scarce. This can be actualized by the cropping of larger hectares, regulated usage of higher quantities of fertilizers and the provision of labour saving machines like water pumps and irrigation devices, which would help reduce labour requirements and enhance efficiency. This would go a long way in addressing the serious nutritional deficiencies in the diets of the average Nigerian.

Key words: Amaranth, efficiency of resource-use, marginal productivities, production function, value of marginal product, Edo South

INTRODUCTION

Current statistics show that two billion people, about a third of the world's population, live on diets that do not contain sufficient amount of vitamins and minerals that are needed for normal growth and development and prevent premature growth, blindness and other disabilities, with over seven million children dying each year from being undernourished (IFPRI, 2002). The main causes of malnutrition stem from poverty of the people and government. Malnutrition is a grave problem for large and poor families who have no funding to buy or grow food. Animal protein has become prohibitively expensive (Imoh and Nwaekpe, 2005), leading to increasing emphasis on plant protein in preference to animal protein in human diets (Ekeleme and Nwofia, 2005). This underscores the importance of vegetables in our diets, which represents a cheap and affordable source of protein and vitamin.

Amaranth (*Amaranthus* species) which is one of the plants often considered as the most important green leafy vegetable of the tropics, because it provides minerals and vitamins (especially vitamin A) in the diets of many developing countries and could be used to circumvent the problem of malnutrition. Amaranth is an easily grown leafy vegetable with high dietary value. Fresh amaranth has a protein weight of 3.1% while the dry one has a protein weight of 25.8% (Messiaen, 1994). Amaranth has the C4 type of photosynthesis and is probably the plant that can produce the highest amount of protein and dry matter per unit of area and of time in the world, about 1.6 g protein per square meter per day (Messiaen, 1994).

The growth and development of vegetables is however closely linked with climatic changes. This has led to scarcity of vegetables during dry season and at the end of dry season. During early rains, there is usually a shortage of green vegetables and amaranth gives an abundance of green leaves during this period. Though amaranth can be grown in the dry season, Messiaen (1994), reports that this must be done in areas near the streams and river and valleys and in irrigated farms. This constitutes the major challenge faced by amaranth growers in Edo South. As a way of circumventing this problem, they prefer to grow their amaranth in the rainy season when they are sure of regular water supply through rain-fed production. The main problem now lies in finding out how to assist the dry season amaranth

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grower in Edo South in organizing his production inputs for improved economic benefits, which would help encourage higher output. He should be able to allocate his resources efficiently so as to minimize production cost and increase output especially in the dry season when amaranth is known to be scarce.

Data on economics of horticultural crops (like amaranth) are scarce in developing countries (Ighalo and Alabi, 2005). This is because horticultural crops are generally cultivated by most farmers as minor crops (Adeniyi, 2001). Micro economic production functions studies have always been the tool for examining the problems of resource productivity and Efficiency of resource-use at the farm enterprise level. In this regard, attention is usually focused on estimates of production coefficients under the neo-classical economic assumption of profit maximization. These tools have been applied by Nwosu (2005), in the estimation of efficiency of resource-use by both ADP and non-ADP farmers in Orlu agricultural zone in Imo State Nigeria, Ike and Ogba in estimating the efficiency of resource use by cassava women farmers in Enugu State, Nigeria. In Edo South, production function, marginal productivities and allocative efficiencies were estimated for cassava farmers by Emokaro and Erhabor (2006). Studies by Ohajianya and Onyenweaku (2001, 2002) pointed to low resource productivity and efficiency in Nigerian agriculture. Omonona (2003) showed that cassava farmers in Kogi State in Nigeria, were not efficient in their use of resources. These studies were however, on other crops and/or in other regions of Nigeria. A gap therefore exists in the fact that no study has been done to ascertain how efficient dry season amaranth farmers in Edo South are in the use of production inputs. This gap is what this study is designed to fill.

This study thus seeks to determine the efficiency of resource use in dry season amaranth production in Edo South. The study will also examine the socio economic characteristics of the farmers with a view to identifying relevant interventions, which would help in boosting amaranth production in the dry season (when it is known to be scarce).

MATERIALS AND METHODS

Study area: This study was carried out between November, 2005 and February, 2006 in Edo South region of Edo State, Nigeria. The State lies within the geographical co-ordinates of longitude 05° 04` East and 06° 43` East and Latitude 05° 44` North and 07° 34` North of the Greenwich. The 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 Mangrove Forest, Fresh 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 temperature ranging from a minimum of 24°C to a maximum of about 33°C.

Sample size and sampling procedure: A simple random sampling of 50% of dry season amaranth producers in the identified areas of production in Edo South was carried out. Consequently 132 copies of a well structured questionnaire were administered to the producers which make up 50% of the total number of dry season amaranth producers in the identified areas. Out of these 132 farmers, 128 returned copies that were found useful for analysis, thus giving a response rate of 97%.

Data collection: The primary data used in this study were collected with the help of a well-structured questionnaire, through the cost-route method of data collection, in order to elicit the right response and objective information from the respondents.

Underlying analytical techniques

Choice of production function: Two types of functional forms of production, commonly used in production function analysis were examined in this study. This was done because the researchers were not sure of the form of relationship that existed between the production inputs and outputs in the vegetable industry.

The two functional forms examined were the Linear and the Exponential Production Functions presented in Eq. 1 and 2 below.

Linear: $Y = A_0 + A_1X_1 + A_2X_2 + A_3X_3 + \text{---} + AnXn + \mu_1$ (1)

Exponential: $\log Y = \beta_0 + \beta_1 \text{Iog}\, X_1 + \beta_2 \text{Iog}\, X_2 + \beta_3 \text{Iog}\, X_3 + \mu_2$ (2)

Where:

Log = Used for linearizing exponential production functions
Y = Naira value of amaranth
X_1 = Hectares of land planted to amaranth
X_2 = Man-days of labour used in respect of amaranth production
X_3 = Quantity of fertilizer applied to amaranth (in tones)
A_0 and β_0 = Constants (intercept)
A_1-β_3 = Regression Coefficients
μ_1 and μ_2 = Disturbance terms expected to fulfill all OLS assumptions.

Marginal productivities and efficiency of resource-use: Two factors generally determine the productivity of inputs namely, the quantity of it already used in the production process and the level of the other resources with which it is combined. For this reason, the estimates with the widest applicability are those derived at the geometric mean input levels. The geometric means of the inputs were therefore used in determining the Value of the Marginal Products (VMPs). The market prices that prevailed during the production season were used in determining the geometric mean of input and output prices, while the cost of renting one hectare of farmland was taken as the market price of land. According to the equi-marginal principle in economic theory, a production input is being used efficiently if the ratio of the VMP of an input and the unit price of the input equals unity.

RESULTS AND DISCUSSION

Socio-economic characteristics of farmers

- **Sex distribution:** Results of the study showed that more males (118 or 92% of the respondents) were involved in dry season amaranth production than females, who constituted only eight percent of the respondents. The large disparity could be attributable to the drudgery associated with dry season amaranth production, as attested to by the farmers.
- **Age distribution:** Most of the farmers (75%) were aged 46 years and above, with the remaining 25% aged below 46 years. This indicates that a high percentage of the dry season amaranth growers in the study area are in their most productive years.
- **Farm size:** Table 1 shows the farm size distribution of the respondents. As shown in the table, all the farmers cropped less than one hectare of farmland throughout the production season. While 66% of the farmers had average farm sizes that ranged between 0.026 and 0.050 hectare, 6% had farm sizes that ranged between 0.051 and 0.075 hectare and 26% had farm sizes that ranged between 0.076 and 0.100 hectare. This shows that dry season amaranth producers in Edo South are smallholder farmers.

These results compare favourably with the findings of Ehirim *et al.* (2005), who studied the economic impact of common agronomic practices associated with risk control in cassava production in Owerri, Nigeria and reported a predominantly male farming community (71%) with over 12 years farming experience, a mean household size of seven persons and an age distribution which showed that over 40% of the farmers were within the age range of 42 to 54 years, while 30% of the farmers were above 62 years. The conclusion was that the farmers were within the active age of farming.

Marginal productivities and efficiency of resource-use: Marginal Physical Product (MPP) for each of the production inputs were estimated from the regression coefficients, which represents the elasticity of production in an Exponential Production Function (Table 2). This was done after it had been selected as the best fit on the basis of the R^2, R, adjusted R^2 and F ratios, the reasonableness of the magnitude of the respective coefficients and the a priori econometric expectation of signs of the estimated parameters (Koutsoyiannis, 2003; Emokaro and Erhabor, 2006).

The estimated values of the MPPs of the inputs, the VMPs and the respective efficiency estimates are presented in Table 3. Two of the major determinants of the VMP are the technical efficiency in production and the magnitude of the price level of the product. The estimated average price of one tonne of amaranth produced by the farmers was ₦ 8,000. This average price level of output is a major determinant of the VMP, which represents the addition to total revenue arising from an additional input used in the production process. The mean input price of land was estimated as one third of the annual rental cost/ha of farm land in the study area, since dry season amaranth production was only carried out for a period of four months. That of labour was taken as the average cost

Table 1: Distribution of farm size for dry season amaranth production in Edo South

Farm size (ha)	Frequency	Percentage	Mean farm size (ha)
0.001-0.025	-	-	-
0.026-0.050	84	66	0.046
0.051-0.075	8	6	0.067
0.076-0.100	36	28	0.093
Total	128	100	

Table 2: Estimated production function

LogY	Constant log X_1	log X_2	log X_3	R^2	Adjusted R^2	F	SE	R
8.91	0.79	0.08	0.17	0.89	0.88	77.99	0.12	0.95
	(0.072)	(0.014)	(0.025)					

Figures in parenthesis are t values

Table 3: Ratio of $VMPx_i$ to input prices at geometric mean of input

Variables	β_1	$MPPx_i$	VMPxi (₦)	Mean input price (Pxi)	VMPxi/Pxi	Inference
Land (X_1)	0.79	6.96	55,680	₦ 10,000	5.57	Under-utilized
Labour (X_2)	0.08	0.02	160	₦ 600	0.27	Over-utilized
Fertilizer (X_3)	0.17	0.20	1,600	₦ 900	1.78	Under-utilized

Source: Computed from field survey Data 2006 of hiring a farm hand per day in the region, while that of fertilizer was estimated as the average cost per tonne of farm yard manure used by the farmers. Consequently, estimates of the VMP of inputs and the ratios of the unit prices of inputs were worked out (Table 3).

Within the limits of statistical reliability, these values provide a measure of the efficiency of resource-use prevailing on the average, in dry season amaranth production in Edo South. A production input is efficiently utilized if the ratio of the VMP/input price equates to unity, a ratio less than unity indicates over-utilization of production inputs in the production process, considering the existing price condition and the degree of availability of other production inputs. A ratio greater than unity shows that resources are under-utilized. Based on this theory, land and fertilizer were shown to be under-utilized, with ratios greater than unity. Labour was however, over-utilized. This finding is in consonant with the findings of Nwosu (2005), who showed that land was under-utilized while labour was over-utilized by both ADP and non-ADP farmers in Orlu agricultural zone of Imo State, Nigeria. It however contrasts that of Ike and Ogba (2005) who showed that farm size, family labour, hired labour and cassava cuttings were all over-utilized in a study of the efficiency of resource-use by cassava women farmers in Enugu State, Nigeria. In other studies by Ohajianya and Onyenweaku (2001, 2002) it was shown that low resource productivity and inefficiency exist in Nigerian agriculture. Omonona (2003) showed that cassava farmers in Kogi State, Nigeria were not efficient in their use of resources.

The logical conclusion from this is that there exist great potentials for dry season amaranth growers in Edo South to improve on their current level of efficiency in the use of production inputs. This, by implication, would translate to higher profit margins if larger hectares of farm land are cropped, more (but regulated) quantities of fertilizer is applied and labour saving machines are employed in the production process. Government and non-governmental authorities can intervene by providing water pumps, sprinkler irrigation machines and other labour saving devices. These would help reduce the drudgery associated with dry season amaranth production in the region and encourage more efficient use of labour. It is hoped that such measures would go a long way in addressing the scourge of malnutrition in the region, by helping to further enrich the diet of the average consumer in Edo South through increased availability of amaranth, especially in the dry season when it is known to be scarce.

CONCLUSIONS

This study employed the use of a stratified random sampling technique in collecting data from 128 dry season amaranth growers for analysis. Results from the study showed that dry season amaranth producers in Edo South are smallholder farmers, predominantly males, with mean farm sizes ranging between 0.046, 0.067 and 0.093 hectare. Efficiency of resource-use estimates were 5.57, 1.78 and 0.27 for land, fertilizer and labour respectively. This shows that land and fertilizer were under-utilized, while labour was over-utilized. Enough potential therefore exist for increased production of amaranth, especially in the dry season when amaranth is known to be scarce. This can be actualized by the cropping of larger hectares, regulated usage of higher quantities of fertilizers and the provision of labour saving machines like water pumps and irrigation devices, which would help reduce labour requirements and enhance efficiency. This would go a long way in addressing the serious nutritional deficiencies in the diets of the average Nigerian, especially in the dry season when the problem is more severe due to relative scarcity of green vegetables.

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