PRODUCTION EFFICIENCY IN YAM BASED ENTERPRISES IN EKITI STATE, NIGERIA

AWONIYI[1], OLUBUKOLA ABIODUN[1], OMONONA, BOLARIN TITUS*[2]

[1]Department of Agricultural Economics and Extension Services, University of Ado Ekiti, Nigeria

[2]Department of Agricultural Economics, University of Ibadan, Nigeria,
E-Mail: btomonona@yahoo.com, Tel: +234-8042120025 and +234-8062731665

Manuscript received: June 20, 2006; Reviewed: January 29, 2007; Accepted for publication: January 29, 2007

ABSTRACT

This paper investigates the production efficiency in yam based enterprises is Ekiti State, Nigeria. Primary data were collected through the use of structured questionnaires from 150 farmers randomly selected from four Local Government Areas. Stochastic frontier production function, using maximum likelihood estimation MLE was used to analyze the economic efficiency. The productivity of resources was also examined by obtaining the Average and Marginal product values.

This study found out three types of yam production systems among the farmers. These are wetland, upland and a combination of the two types of production systems. The MLE results reveal that farm size and yam set weight are the major factors influencing gross margin in wetland yam based enterprises. Gross margin increases with farm size but decreases with yam set weight. The major factors in upland yam based enterprises are farm size, hired labor, pesticides and herbicides. An increase in hired labor input and value of pesticides and herbicides leads to increase in gross margin. Gross margin from wetland/upland yam based enterprises is mainly influenced by family labor, hired labor yam set weight, and pesticides and herbicides. The efficiency models show that in all the three farming systems, as crop diversification increases there is a decline in economic efficiency of the farmers.

The wetland yam based enterprises are the most economically efficient with mean economic efficiency of 0.80 followed by upland yam based enterprises with mean efficiency of 0.79. Wetland/upland yam based enterprises are the least economically efficient with mean efficiency of 0.76. However only 20 percent of the farmers are wetland farmers while as high as 50 percent are upland farmers. Productivity of resources shows that yam set is over utilized in all the three farming systems. In addition to this, family labor and fertilizers are also over utilized in wetland yam based enterprises.

The major conclusion drawn from the study is that farmers should seek to grow their yams on wetland. Also, farmers should address the problem of over utilization of yam set by adopting the yam minisett technology developed by the International Institute for Tropical Agriculture (IITA) and the National Root Crops Research Institute (NRCRI).

Keywords: Yam-based enterprises, wetland, upland, stochastic frontier and efficiency.

INTRODUCTION

Roots and tubers belong to the class of food that basically provide energy in human diet in the form of carbohydrates. The terms refer to any growing plant that stores edible materials in subterranean root, corm or tuber [9]. Interestingly, yam is a member of this important class of food.

As a food crop, the place of yam in the diet of the people in West Africa and in Nigeria in particular cannot be overemphasized. [3] observes that yam contributes more than 200 dietary calories per capita daily for more than 150 million people in West Africa while serving as an important source of income to the people. The fact that yams (and other root crops) are mainly starchy has led to the disparagement of their protein content which is low compared to cereals. However, considering the quantities of yams (and other root crops) consumed a day, their protein contribution is often significant. In addition, root crops generally contain an appreciable amount of vitamins and minerals and may have a competitive production advantage in terms of energy yield per hectare over cereals produced in ecologically difficult conditions. [4] reported in 1997 that yams tend to be higher in protein and minerals like phosphorus and potassium than sweet potatoes though the latter are richer in vitamins A and C. Most yams contain an acrid taste that is dissipated in cooking. The edible species that are most widely diffused in tropical and subtropical countries are the Dioscorea rotundata (white yam) and Dioscorea alata (water yam).

Yam is widely consumed especially in West Africa. It is often pounded into a thick paste after boiling (pounded yam) and is eaten with soup. Yam can also be processed into flour that is used in the preparation of the paste. Yam is a preferred food and a food security crop in some sub-Saharan African countries [8]. Little wonder [3] opines that in many yam-producing areas of Nigeria, yam is food and food is yam. Unlike cassava, sweet potato and aroids, one can store yam tubers for periods of up to 4 or even 6 months at ambient temperatures. This characteristic contributes to the sustaining of food supply, especially in the difficult (food scare) period at the start of the wet season.

Worthy of note is also the fact that many important cultural values are attached to yam, especially during weddings and other social and religious ceremonies. In many farming communities in Nigeria and other West African countries the size of yam enterprise that one has is a reflection of one's social status. Due to the importance attached to yam, many of these communities celebrate yam festival annually.

Problem statement

Over the years, the difficulties faced by many developing countries in satisfying their population's food requirements with domestic food production have increased [7]. Even with sustained efforts, it has not always been possible to meet the growing food demand by raising the domestic production of cereals. As a result widespread food shortages, hunger and malnutrition have persisted particularly among the low-income groups in developing countries.

In order to improve the situation, the member governments of the Food and Agriculture Organization of the United Nations (FAO) at the 8th session of the committee on Agriculture (COAG) in 1985 recommended the adoption of measures to broaden the food base through the promotion of other local food crops of nutritional importance. At its 9th session in 1987, COAG further requested member governments to give high priority to production and consumption of roots and tubers among which yam is chief.

As can be seen from the foregoing, in spite of the tremendous importance of the yams in the West African sub region, the crop has hitherto been neglected in policy decisions related to research, crop production and marketing [3]. Most of the efforts of the policy makers and researchers have been concentrated on cash crops or the more familiar grams [7]. What has been responsible for this neglect? In his own opinion [9] suggests that the neglect can be attributed not only to difficulties in marketing of yams but also to the fact that the crop has suffered from a negative image as "poor people's food". Contrary to this misconception, however, the consumption of yams in urban areas is not negligible. According to [1], the production of yam in Nigeria is grossly inadequate and cannot meet the ever-increasing demand for it under present level of input use. In order to meet this level of demand and even surpass it, there is need to assess the level of efficiency and its determinants across the two types of farmland used: upland and wetland. This is what the study is set out to do.

Probably if policy makers eventually focus attention on yam and high priority is given to its production, farmers will receive incentives vis-à-vis a higher level of technology. However, the fact remains that for every bundle of inputs used in a production process there is a potential quantity of output then can be produced. Considering the present situation where farmers still use traditional (manual) technology therefore it would be pertinent to ask has the potentials of this technology been fully harnessed?

METHODOLOGY

In order to get a representative sample and to achieve the objective of the study, random sampling procedure was employed. Ekiti state, which is the study area, is divided into two ADP zones. Two Local Government Areas were selected in all, one from each zone. The sampling was done in such a way that every Local Government Area has the same chance of being selected.

The data for the study were essentially from primary sources with the use of well-structured questionnaire. The data were collected from some villages in the two Local Government Areas that were selected. Seventy-five farmers were randomly selected from each Local Government Area, which implies that 150 respondents supplied the data for the study. These respondents were farmers who produce yams (Dioscorea rotundata) regardless of whether or not they produce other food crops.

The range of data collected covered those on farm size, family and hired labour input, yam set weight, pesticides and herbicides input and fertilizer input. Also data were collected on household socioeconomic variables such as age, education, marital status and family size. Based on the information gathered from the farmers, they were categorized into wetland, upland and wetland/upland farmers for proper analysis and comparison.

The stochastic production frontier model used for analysis is of the form

$Q_i = f\ (x_i, \beta)\ \rho^{\varepsilon}$ following [10]

Where $\Sigma = ų̨ + V$

V is a symmetric random error that is assumed to account for measurement error and other factors not under the control of the farmer e.g. weather and luck [11], while ų reflects the technical inefficiency i.e. what is left for the farmer to reach the outer bound production function or the frontier.

Q_i = output of the i th farmer (obtained using gross margin)
X_i = vector of inputs
β = vector of parameters to be estimated

To estimate β, the stochastic production frontier model has to be linearised thus:

$$\ln Q_i = \beta_o+\beta_1 \ln x_1+\beta_2 \ln x_2 +\beta_3 \ln x_3 +\beta_4 \ln x_4+\beta_5 \ln x_5 + \beta_6 \ln x_6$$

The output (Qi) here is the farm gross margin. Hence the measure of efficiency is economic efficiency (this is done because of the difficulty in getting the output of the farmers in kilogrammes). [6] did similar thing.

X_1 = farm size (hectares)
X_2 = family labour used in production (man days)
X_3 = hired labour used in production (₦)
X_4 = size of yam set (kg)
X_5 = pesticides and herbicides (₦)
X_6 = fertilizers (₦)

In the efficiency analysis, certain factors that contribute to the ability of the farmers to operate on the frontier were examined.

$$\eta_i = f\ (Zi,\delta)$$

Where $\eta i = 1 - \mu_i$

μ_{i} = economic inefficiency
ηi = economic efficiency
Z_i = vector of farmer specific factors
σ = vector of parameters to be estimated

$$\eta_i = \delta_o + \delta_1 \ln Z_1 + \delta_2 \ln Z_2 + \delta_3 \ln + \delta_4 \ln Z_4 + \delta_5 \ln D_1 + \delta_6 \ln D_2$$

Z_1 = age of farmer
Z_2 = years of experience in yam production
Z_3 = crop diversification variable (number of other crops grown)

Z_4 = number of extension visits in the cropping season
D_1 = dummy variable scored 0 for farmers with less than 6 years of formal education and 1 for farmers with formal education that is 6 years and above (at least primary education).
D_2= Dummy variable scored 1 for membership of Cooperative Society and 0 otherwise.

The FRONTIER version 4.1 computer programme [5] was used to estimate and also to predict the individual efficiency of the farmers.

The values of the Average Product (AP) and the Marginal Product (MP) for the production factors were also calculated and compared.

MPP = Change in output / Change input = dQ / dX
APP = Output / Input = Q / X.

This was done in order to see which of the variables is being underutilized and which of them is being over utilized.

RESULTS AND DISCUSSIONS

THE FARMERS' FARMING SYSTEMS

The respondents in the study area have been categorised into 3 – those who produce yam exclusively on wetland, those who produce theirs exclusively on upland and those who produce yam on both wetland and upland. Table 1 shows the distribution of farmers in the three groups and their mean economic efficiencies.

Upland yam based enterprises are the most popular among the sampled farmers as 50 percent (half) of the respondents are upland farmers. This is followed by wetland/upland yam based enterprises (30 percent of the respondents). The least popular are the wetland yam based enterprises.

Wetland yam based enterprises are the most efficient in terms of economic efficiency with a mean economic efficiency of 0.80. The wetland farms are closely followed by the upland farms, which have the mean economic efficiency of 0.79. The least efficient in terms of economic efficiency are the wetland/upland yam based enterprises whose mean economic efficiency is 0.76. The relatively high economic efficiency of wetland farmers and the upland farmers may be due to the fact that farmers are more focused when they operate single farming system. Wetland yam based enterprises are the most efficient presumably because of adequate water supply to the crops and the higher fertility of the soil than upland.

THE STOCHASTIC FRONTIER ANALYSIS

The stochastic production function was estimated separately for wetland farmers, upland farmers, and farmers growing their yams on both upland and wetland. The analysis was also run for the pooled data. The estimated parameters and the related statistical test results obtained from the analysis are presented in Tables 2 and 3

The Diagnostic Statistics

The estimated sigma squared (σ^2) for the wetland, upland, and wetland/upland yam based enterprises (0.05, 0.095, 0.037 respectively) are significantly different from zero at 1 percent level likewise that of the pooled data, which is 0.08. This indicates a good fit and the correctness of the specified distributional assumptions of the composite error term. Also the magnitude of the variance ratios estimated at 0.99 for each of the three groups and 0.97 for the pooled data are high suggesting that systematic influences that are unexplained by the production function are the dominant sources of errors. This means that for each group 99 percent of the variation in gross margin among the farms is due to differences in economic efficiency.

Estimates of the Parameters of the Production Factors

Based on the information contained in Tables 2and 3, the stochastic frontier model can be written as:

(a) WETLAND

$\text{In } Q_i = 0.30 + 0.91 \text{ In } X_1 - 0.50 \text{ In } X_2 + 0.12 \text{ In } X_3 - 0.77\text{In } X_4$

(0.92)*** (0.31)*** (0.52) (0.11) (0.33)***

$+ 0.29 \text{ In}X_5 - 0.65 \text{ In}X_6$

(12.12) (0.29)

(b) UPLAND

$\text{In } Q_i = 4.95 + 0.86 \text{ In}X_1 + 0.04 \text{ In}X_2 + 0.05 \text{ In}X_3 - 0.15 \text{ In}X_4$

(0.60)*** (0.23)*** (0.04) (0.02)** (0.16)

$+ 0.05 \text{ In}X_5 + 0.06\text{ln}X6$

(0.02)*** (0.02)***

Table 1: Distribution of farmers by farming system

FARM SITE	FREQUENCY	PERCENTAGE	MEAN EFFICIENCY
Wetland	30	20	0.80
Upland	75	50	0.79
Wetland/upland	45	30	0.76
Total	150	100	

Source: Field Survey, 2004

Table 2: Maximum likelihood estimates of the parameters of the stochastic frontier production function (economic efficiency model)

VARIABLE	PARAMETER	COEFFICIENT AND STANDARD ERROR		
		WETLAND	UPLAND	WETLAND/UPLAND
Production factors				
Constant	β_0	0.30 (0.92) ***	4.95 (0.60) ***	0.71 (0.89)
Farm size (X_1)	β_1	0.91 (0.31) ***	0.86 (0.23) ***	0.44 (0.29)
Family labour (X_2)	β_2	-0.50 (0.52)	0.04 (0.04)	0.29 (0.13) **
Hired labour (X_3)	β_3	0.12 (0.11)	0.05 (0.02) **	0.11 (0.04) ***
Yam set (X_4)	β_4	-0.77 (0.33) ***	-0.15 (0.16)	-0.99 (0.29) ***
Pesticides& Herbicides (X_5)	β_5	0.29 (0.12)	0.05 (0.02) ***	0.15 (0.07) **
Fertilizer (X_6)	β_6	-0.65 (0.29)	0.06 (0.02) ***	0.004 (0.03)
Efficiency factors				
Constant	δ_0	-1.77 (0.93) *	0.82 (0.43) *	-0.38 (0.14) ***
Age (Z_1)	δ_1	0.035 (0.02) *	-0.006 (0.01)	0.017 (0.005) ***
Farming experience (Z_2)	δ_2	0.02 (0.02) *	0.013 (0.012)	0.11 (0.007) *
Crop Diversification (Z_3)	δ_3	-0.17 (0.09) *	-0.23 (0.09) ***	-0.04 (0.029)
No of extension visits (Z_4)	δ_4	0.025 (0.06)	-0.09 (0.04) **	-0.022 (0.019)
Education (D_1)	δ_5	0.32 (0.17) *	0.097 (0.17)	0.24 (0.07) ***
Coop. Societies membership (D_2)	δ_6	-0.032 (0.16)	-0.25 (0.20)	0.15 (0.122)
Diagnostic statistics				
LogLikelihood function		14.9	34.84	27.08
Sigma squared (σ^2)		0.05 (0.012) ***	0.095 (0.03) ***	0.037 (0.007) ***
Gamma (Y)		0.99 (0.035) ***	0.99 (0.00005) ***	0.99 (0.0000001) ***

*** Significance at 0.01 level; ** at the 0.05 level; * at the 0.10 level
Figures in parentheses are the standard errors.
Source: Computer printout of MLE results.

(c) WETLAND/UPLAND

$$\ln Q_i = 0.71 + 0.44 \ln X_1 + 0.29 \ln X_2 + 0.11 \ln X_3 - 0.99 \ln X_4$$
(0.89) (0.29) (0.13)** (0.04)*** (0.29)***

$$+ 0.15 \ln X_5 + 0.004 \ln X6$$
(0.07)** (0.03)

(D) POOLED RESULTS

$$\ln Q_i = 4.63 + 0.74 \ln X1 + 0.09 \ln X2 + 0.09 \ln X3 - 0.06 \ln X4$$
(0.38)*** (0.13)*** (0.10) (0.02)*** (0.09)

$$+ 0.06 \ln X_5 + 0.008 \ln X_6$$
(0.02)*** (0.01)

There is a positive relation between farm size and gross margin across all the three groups of farmers. This implies that the larger the farms size the more the gross margin. The magnitudes of this coefficient are 0.91, 0.86, and 0.44 for wetland, upland and wetland/upland enterprises respectively and 0.74 for the pooled data. This shows that the gross margin in the yam-based enterprises is elastic to changes in the level of cultivated land area. The coefficient is significant at 0.01 level in wetland and upland enterprises and also in the pooled equation. It is however not significant at all in wetland/upland enterprises. Land (farm size) is therefore a significant factor associated with changes in the gross margin in wetland yam based enterprises and upland yam based enterprises.

The coefficient of family labour in wetland yam based enterprises is negative and statistically not significant. Though the coefficient is positive in all other equations it is statistically significant only in wetland/

Table 3:Maximum likelihood estimates of the parameters for the pooled data

VARIABLE	PARAMETER	COEFFICIENT AND STANDARD ERROR
Production factors		
Constant	β_0	4.63 (0.38) ***
Farm size (X_1)	β_1	0.74 (0.13) ***
Family labour (X_2)	β_2	0.09 (0.10)
Hired labour (X_3)	β_3	0.09 (0.02) ***
Yam set (X_4)	β_4	-0.06 (0.09)
Pesticides & Herbicides (X_5)	β_5	0.06 (0.02) ***
Fertilizer (X_6)	β_6	0.008 (0.01)
Efficiency factors		
Constant	δ_0	0.16 (0.27)
Age (Z_1)	δ_1	0.002 (0.006)
Farming experience (Z_2)	δ_2	0.006 (0.94)
Crop Diversification (Z_3)	δ_3	- 0.09 (0.04) **
No of extension visits (Z_4)	δ_4	- 0.03 (0.02) **
Education (D_1)	δ_5	0.13 (0.09)
Coop. Societies membership	δ_6	0.05 (0.10)
Diagnostic statistics		
Log Likelihood function		44.64
Sigma squared (σ^2)		0.08 (0.03) ***
Gamma (Y)		0.97 (0.02) ***

*** Significant at the 0.01 level, ** at the 0.05 level, at the 0.10 level.
Figures in parentheses are the standard errors
Source: Computer Printout of MLE results.

upland yam based enterprises at the 0.05 level. This shows that in wetland/upland yam based enterprises; gross margin is expected to increase with an increase in family labour input while family labour is not a significant factor in other yam-based enterprises.

Hired labour is a positive but not significant factor in wetland yam based enterprises. In the upland, wetland/upland yam based enterprises and the pooled equation hired labour is also a positive factor. The coefficient is significant at the 0.05 level in the upland yam based enterprises and at the 0.01 level in both the wetland/upland yam based enterprises and the pooled equation. Hence increase in the hired labour input in the upland and wetland/upland yam based enterprises will lead to an increase in the gross margins. The production elasticities of 0.05 and 0.11 with respect to hired labour in upland and wetland/upland yam based enterprises shows that gross margin is inelastic to changes in the amount of hired labour used. In other words, a 1 per cent increase in hired labour would cause an increase of just 0.05 percent and 0.11 percent respectively in the farm gross margin of upland and wetland/upland yam based enterprises in the study area.

The elasticities of output with respect to the weight of yam set planted across all the 3 groups are negative at –0.77, -0.15, and -0.99 respectively for wetland, upland and wetland/upland farms and –0.06 in the pooled equation. The coefficient of yam set is however significant at 0.01 level only in wetland and wetland/upland farms. It shows that the size of yam set planted is not in anyway directly proportional to the gross margin. This is reasonable since before the yam set could sprout it must first decay and only a small portion of the set is actually needed for germination to take place. This informs the development of yam miniset production technology by the IITA (International Institute for Tropical Agriculture). This technology uses smaller yam sets and according to Babaleye (2003) the production technology is thus cost effective.

The production elasticities with respect to pesticides and herbicides are positive across all the 3 groups and in the pooled equation but it is not statistically significant in the wetland yam based enterprises. Hence an increase in the amount expended on pesticides and herbicides leads to an increase in gross margin in both the upland and wetland/upland yam based enterprises.

The elatiscities of output with respect to fertilizer are positive in upland and wetland/upland farms and also in the pooled equation. The elasticity in the wetland farms is however negative. The coefficient is statistically significant only in the upland farms at the 0.01 level. The value of the coefficient (0.06) in upland farms indicates that 1 percent increase in the amount of fertilizers applied to the farm leads to a 0.06 percent rise in the gross margin. It is important to point out that the farmers in the study area do not apply fertilizer to yam directly. However when yam is intercropped with maize and N.P.K. fertilizer is applied to the latter, the effect is also seen on the yams.

Estimates of the Parameters of the Efficiency Factors

The sources of efficiency are examined by using the estimated coefficients in Table 1and 2 and based on this, the efficiency models can be stated thus:

(a) WETLAND

η_i = -1.77 + 0.035In Z_1 + 0.02In Z_2 + 0.12 In Z_3

(0.93)* (0.02)* (0.02)* (0.09)*

+ 0.25InZ + 0.32InD_1 + 0.32InD_2

(6.06) (0.17)* (0.16)

(b) UPLAND

η_i = 0.82 - 0.006ln Z_1 + 0.013lnZ_2 - 0.23 lnZ_3 – 0.09 lnZ_4

(0.43)* (0.01) (0.012) (0.09)*** (0.04)***

+ 0.097lnD_1 – 0.25 lnD_2

(17.17) (0.20)

(c) WETLAND/UPLAND

η_i = -0.38 + 0.017lnZ1 + 0.01lnZ2 - 0.04lnZ_3 - 0.022lnZ_4

(0.14)*** (0.005)*** (0.007)* (0.029)** (0.019)

+ 0.24lnD_1 + 0.15lnD2

(0.07)*** (0.122)

(D) POOLED RESULTS

η_i = 0.16 + 0.002lnZ1 + 0.006lnZ2 + 0.09lnZ3 - 0.03lnZ4

(0.27) (0.006) (0.94)** (0.04)*** (0.02)***

+ 0.13lnD_1 + 0.05lnD2

(0.09) (0.10)

In the equation for upland yam based enterprises, the coefficient of age is negative. However in all the other equations the coefficient is positive. It is significant at the 0.01 level in the wetland/upland farms and at the 0.10 level in the wetland farm. This shows that there is an increase in the economic efficiency of farmers in wetland and wetland/upland farms as the farmers advance in age.

The coefficient of experience variable is estimated to be positive in the pooled data and across all the 3 groups. It is however statistically significant at the 0.10 level only in both wetland and wetland/upland farms. Hence in both wetland and wetland/upland farms the more the years of experience a farmer has on his yam based enterprise the more economically efficient he is.

The coefficient of crop diversification variable is negative in all the models. It is statistically significant at the 0.10 level in the wetland farms; at the 0.01 level in the wetland/upland model and at the 0.05 level in the pooled equation. This finding agrees with comparable finding by [2]. As diversification decreases, that is as the farmers grow fewer crops, economic efficiency increases. The implication is that greater diversification is associated with lower relative efficiency, while greater specialization in crop production is associated with higher relative efficiency.

There is a negative relation between the extension contact variable and efficiency effect in the upland and wetland/upland farms and also in the pooled data. The coefficient is statistically significant at the 0.01 level in the upland model and at the 0.05 level in the pooled equation. One would expect that increase in extension services to farmers would increase efficiency in yam based enterprises, but this is not so in the models rather increase in number of extension visits leads to a decrease in the economic efficiency of the farmers. It is either that the quality of extension service is poor in the study area (for example, may be wrong information is being passed to the farmers from extension quarters) or the farmers do not follow extension advice to the letter.

The coefficients of education variable in all the models show positive relation with predicted efficiency though the coefficient is statistically significant only in the wetland farms and at the 0.10 level. The positive relation indicates that farmers with higher level of education are more economically efficient

Like the education variable, the coefficient of cooperative variable was also specified as a dummy. The coefficient is negative in the wetland and upland farms but positive in wetland/upland farms. However it is statistically not significant in all the models.

PRODUCTIVITY OF RESOURCES

The values of the Average Product (AP) and the Marginal Product (MP) for the production factors are calculated and compared. This is done in order to see which of the variables is being underutilized and which of them is being over utilized. The result is presented in Table 4.

Table 4: Average product and marginal product values

Variables or Production factors	Wetland		Upland		Wetland /Upland	
	AP	MP	AP	MP	AP	MP
Land X_1	75482.6	68689.2	83590	7188.74	68140.9	29982
Family labour (X_2)	2287.4	-1143.7	2264.9	88.33	2523.7	731.87
Hired labour (X_3)	9.91	1.19	10.27	5.27	11.51	1.27
Yam set (X_4)	50.3	-38.73	53.22	-7.98	46.5	-46.04
Pesticides and herbicides (X_5)	41.6	12.06	29.44	1.56	60.64	9.1
Fertilizer (X_6)	19.8	-12.87	16.35	0.93	20.26	0.08

Table 4 reveals that the Average Product (AP) with respect to family labour in wetland yam based enterprises is higher than its Marginal Product. The Marginal Product (MP) is also negative. This shows that production with respect to family labour in wetland yam based enterprises is in stage III. This implies that each additional unit of family labour used in production makes a negative contribution to the output. The same explanation goes for yam set and fertilizers in wetland yam based enterprises since the Marginal Products with respect to these variables are also negative. Therefore, family labour, yam set and fertilizers are over utilized in wetland yam base enterprises.

Yam set in all the 3 farming systems is actually over utilized since the Marginal Product with respect to yam set is negative in the 3 groups. In all the other variables the Marginal Products (MP) are positive but lower than the Average Products (AP), which suggests that production with respect to these variables is in stage II. This is the only rational stage to produce.

CONCLUSION AND RECOMMENDATIONS

Wetland yam based enterprises are the most economically efficient with mean economic efficiency of 0.80. They are however the least popular among farmers probably due to inadequate access to wetland. Wetland/upland enterprises are the least efficient in terms of economic efficiency with mean economic efficiency of 0.76 while upland yam based enterprises are the most popular among farmers with mean economic efficiency of 0.79. Wetland/upland are the least efficient in terms of economic efficiency because farmers are not focused when they grow yams on both wetland and upland. It is even better that farmers grow their yams only on upland than moving between wetland and upland.

The Maximum Likelihood Estimates MLE results show that farm size and yam set weight are the major factors that are associated with changes in the gross margin from wetland yam based enterprises. In the upland yam based enterprises, the major factors are farm size, hired labour, pesticides and herbicides, and fertilizers. Gross margin in the wetland/upland yam based enterprises is mainly determined by family labour, hired labour, pesticide and herbicides, and yam set weight. Analysis of the productivity of resources shows that yam set is overutilised in the entire yam based enterprises.

In the efficiency model, the coefficient of crop diversification especially in the wetland and upland farms show that the fewer crops a farmer grows with yam, the more economically efficient he is.

From the foregoing, the study recommends that farmers should seek to grow their yam on wetland. Besides, the size of yam set the farmers plant should be reduced to minimize cost since the size of yam set planted is not in any way directly proportional to the gross margin. Farmers can adopt the yam minisett technology developed by the International Institute for Tropical Agriculture (IITA) and the National Root Crops Research Institute (NRCRI).

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