Comparative Analysis Of Resource Use Efficiency In Rice Production Systems In Abia State Of Nigeria

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ABSTRACT: Arresting the observed low productivity and continued decline in the output of rice especially in the face of rising population and the concomitant escalating increases demand has been a lingering socioeconomic problem. Continued increase in rice production through a number of options including expansion into high potential areas especially the inland valleys has been proposed. This study was designed to examine resource use efficiency in rice production systems in Abia State of Nigeria. Primary data collected from a sample of 142 farmers consisting of 46 inland valley, 41 upland and 55 swamp rice farmers were analysed by the ordinary least squares multiple regression analysis and analysis of variance (ANOVA). Results indicate that the upland rice farmers are technically more efficient than the swamp and inland rice farmers and that there is no difference in technical efficiency between the swamp and inland rice farmers. None of the farmer groups achieved absolute allocative efficiency. The upland rice farmers achieved least allocative efficiency (Wij is farther from unity), underutilized all farm resources (Wij >1) while both the inland valley and the swamp rice farmers under utilized farmland, other inputs and capital and over utilised (Wij < 1) family labour and hired labour. There was no significant difference in the mean output of rice from the production systems; upland, inland valley and swamp while each operated in region one on the production surface indicating that overall, resource levels could be increased to achieve higher levels of productivity in each system. Economic policies and programmes that could encourage the reallocation and if possible the redistribution of farm production inputs for increased farm productivity and efficiency were recommended. [Journal of American Science 2010;6(11):396-408]. (ISSN: 1545-1003).

Key words: Resource use efficiency, rice production systems, Nigeria.

INTRODUCTION

The struggle for food is desperate for the 240 million people of West Africa: one of every three of who is a Nigerian (WARDA, 2002). Nigeria has experienced rapid growth in per capita rice consumption during the last three decades from 5Kg in the 1960s, 11Kg in the 1980s to 25 Kg in the 1990s (IBRD, 1994; WARDA, 2003). An estimated 2.1 million tonnes of rice are consumed annually in Nigeria; this has increased since the mid 1980s at an average annual rate of 11 percent of which only 3 percent can be explained by population growth while the remaining percentage represents a shift in diet towards rice at the expense of the coarse grains (millet and sorghum) and wheat (WARDA, 2003). Erenstein and Lancon (2002) noted this shift and posited that the most important contributory factors are rapid urbanization and the associated changes in family occupational structures. The resultant increases in the opportunity cost of family members' time makes convenience foods such as rice to rise in prominence in the family menu.

Unfortunately, Nigerian rice output is low and declining by 3.4 percent in 1997 (CBN, 1998). Odii and Nwosu (1996) noted that the decline is traceable to inefficient use of farm resources, labour shortages and severe scarcity of resources, poor crop management practices and poor capital base. Moreover, WARDA (2002) opined that inconsistency, shifting between open and protectionist trade policy characterize rice policy in Nigeria. As a result yield potential are not fully achieved on rice farms although high yielding varieties and the associated technologies exist and are already being used by the farmers (Nwaru, 2002). Consequently, Nigeria has depended heavily on imported rice to meet her consumption needs and has become the World's largest importer of rice (WARDA, 2003). That Nigeria has remained a net importer of rice with well over 150.15 billion naira spent annually (FOS, 2000) is indicative of the declining self-sufficiency.

Continued increase in rice production has been proposed through a number of options. Carsky (1992) posited that it would be possible through continued expansion into high potential areas especially the inland valley bottoms in the Midwest and Southeast and the alluvial lowlands along the Niger and Benue Rivers. Iheke (2006) noted that additional gains could be achieved through investment in water control particularly small-scale systems in inland valleys. In deed, rice-growing environments in Nigeria are usually classified into rain fed, upland, rain fed lowland, irrigated lowland, deep water and swamp (Cobley, 1976; WARDA, 1999). Inland valleys are potential agro ecosystems that have substantial impact on African food production especially rice. IITA (1988), Izac, et al, (1991) and Windmeijer and Andriesse (1993) noted that substantial increases in rice production in Sub Sahara Africa would come from inland valleys as they have the potential for increased rice productivity.

Carsky (1992) described inland valleys as small valleys that are located near the coast and do not have long flood plains. They are in the upper reaches of watersheds having no large flood plains typical of large rivers or salinity and sulphur problems typical of coastal valleys (Carsky and Masajo, 1992). According to Andriesse (1986) an inland valley starts at a water source as a stream flow valley, which further downstream becomes a river over flow valley. WARDA (1978) and Carsky (1992) noted that though a substantial amount of research has been conducted on rice, there have been fewer studies on rice production in the inland valleys; placing rice production efforts in the inland valleys at less than 10 percent while between 14 to 22 percent was concentrated on each of the other rice ecosystems; upland and lowland. For instance, in a recent study on rice production, (Idiong, 2006) only categorized rice-growing environments into upland or lowland (swamps) rain fed or irrigated, neglecting inland valleys.

Therefore, the objective of this study is to compare the technical and allocative efficiencies as well as the mean output and the returns to scale of the rice farmers in Abia State of Nigeria according to the upland, lowland and inland valley production systems. Technical efficiency refers to the ability of production units to produce maximum outputs from a given set of inputs. It indicates all the undisputed gains obtainable by simply gingering up the management (Farrel, 1957; Iheke, 2006). Observed differentials in technical efficiency may be due to the differences in managerial ability, employment of different levels of technology as indicated by the quality and type of resources used, differences in environmental conditions such as soil quality, rainfall, temperature, solar radiations and precipitation or non technical and non economic factors such as sicknesses which may prevent the user of the resources from working hard enough, thus failing to achieve the best level of output (Nwaru, 1993). Allocative efficiency refers to the ability of the resource user to choose the optimum combination of inputs consistent with the relative factor prices (Onyenweaku, 1994). It has to do with the extent to which farmers make efficient decisions by using inputs up to the level at which their marginal contribution to the value of production is equal to the factor costs. The product of technical and allocative efficiencies is production efficiency, which measures the success of the production unit in choosing an optimal set of inputs and the gains that can be obtained by varying the input ratios on certain assumptions about the future price structure.

It is believed that the productivity of the farmers in general and rice farmers in particular could be enhanced through enhancing their technical and allocative efficiency in response to better information and education (Idiong, 2006). With the difficulties encountered by farmers in developing countries for developing and adopting improved technologies due to resource poverty, efficiency has become a very significant factor in increasing productivity (Ali and Chandry, 1990). The drive is for the farmers to allocate their resources to those productive ventures that earn higher returns for each unit of resource spent. There might be re-allocation of available resources if they expect to benefit more from such economic actions. Idiong (2006) observed that a few published empirical works have attempted to compare efficiency between or among rice production systems in Nigeria generally and in Cross River State of Nigeria in particular. This he attempted to do but stopped only at the comparism of upland and lowland rice production systems leaving out the inland valleys. This study sought to fill this gap.

MATERIALS AND METHODS

The study was carried out in Abia State of Nigeria. The State lies between latitude 5o 25/ North and Longitude 7 o 30/ East. It is divided into Ohafia, Umuahia and Aba Agricultural Zones. The predominant soil of the area is sandy loam while the natural vegetation is the tropical rainforest (Iheke, 2006) and is characterized by two distinct seasons; dry and wet seasons. The dry season lasts from November to March while the wet season lasts from April to October.

The settlement pattern in most part of Abia State is still rural and farming is the predominant occupation of the inhabitants. Most families are involved in one farming activity or the other as a primary or secondary occupation. The region is blessed with favourable warm climate and sufficient moisture ideal for the growing of tree crops, root and tuber crops, cereals, vegetables, nuts and food crops including rice. Livestock are also kept especially on a smallholder basis. The crops are typically grown on smallholder plots. Most crops are grown in mixtures. Rice stands out as a crop essentially grown sole.

Ohafia Agricultural Zone is well noted as the major area of rice production in Abia State of Nigeria. Men and women are involved in the production, processing and marketing of rice in the Zone. The production systems are inland valleys, upland and swamp. The inland valleys are small valleys that do not have long flood plains, located in the upper breaches of watersheds. They usually start at a water source like a stream flow valley, which further down steam becomes a river overflow valley. Swampland arises due to water logging as a result of the topography of the soil and the soil characteristics. The uplands are rain fed or irrigated lands not prone to water logging. They are ideal for the growing of such arable crops as maize, cassava, yam and upland rice that does not tolerate water logged soils.

A multi-stage sampling technique was used in choosing the sample. Ohafia Agricultural Zone was purposively selected for being the major rice production area in the State. Two Local Government Areas in the Zone, based on performance in rice production, were purposively selected for the study. From each of the chosen LGAs, 3 blocks were randomly selected from which 6 ADP cycles were randomly chosen. Five villages in each cycle were randomly selected. A rapid appraisal of the study area was undertaken and questions posed to village heads, resident agricultural extension agents and key informants helped in preparing the list of rice farmers in each chosen village. This list formed the sampling frame from which a sample of rice farmers was selected using simple random sampling procedure. In all, 142 rice farmers comprising of 46 inland valley, 41 upland and 55 swamp rice farmers were selected.

Preliminary visits were made to the study locations before commencing actual data collection. The visits helped the researchers familiarize themselves with the study locations and establish helpful public relations with village heads, resident agricultural extension agents, key informants and field guides. At this stage, field enumerators were recruited, trained and assigned to the study locations. Also data collection instruments consisting of well-structured questionnaire and interview schedule were pre-tested to standardize them and to give the enumerators adequate orientation. This made for easy understanding by the respondents and easy administration by the field enumerators.

The cost route approach was used in data collection for the entire production period from April to December 2005. By this method, contacts were made with the respondents forth nightly. At each contact, efforts were made to determine and record relevant pieces of information from the respondents. The research instruments found useful at the end of the fieldwork were used for further analysis. Data collected were those on socio-economic characteristics of the respondents such as age, sex, household size, educational background and farming experience. Others were on farm inputs like fertilizer, labour use, farm size, capital assets, paddy prices, credit and extension services, costs and returns (input and output) arising from rice production in the production systems.

For the technical efficiency, the additive multiplicative dummy variable approach suggested by Gujarati (1970) and Maddala (1988), which has been used widely by researchers (Baggi, 1982; Onyenweaku, 1994; Nwaru, 2003; Iheke, 2006) was used rather than the traditional method of fitting separate models and testing the equality of coefficients between them. Although some studies in agriculture have expressed the production function in many ways such as the linear, semi-log, exponential and cobb-douglas forms, the cobb-douglas function appears to be in greater use than the other functional forms because in most cases, it satisfies statistical, economic and econometric conditions better (Sankhayan, 1998). Moreover, it has been found by economists to be most suitable in analyzing production problems of industries and agriculture. It is hence used in this study.

The implicit functional form of the model is (Onyenweaku, 1994):

Y = f (X1 X2, X3, X4, X5, D, ei) (1)

The log linear cobb-douglas functional form is given by:

In Y = InAo + BoD + A1In X1 + B1DInX1 + A2InX2 + B2DInX2 + A3InX3 + B3DInX3+ A4InX4 + B4DInX4 + A5InX5 + B5DInX5 + ei (2)

Where in equations (1) and (2), Y is the output of rice (Kg); In is the natural Logarithm, Ao is the intercept or constant term; Bo is the coefficient of the intercept shift dummy or neutral technical efficiency parameter and D is the dummy variable which takes the value of unity for inland valley and zero for upland; unity for inland valley and zero for swamp and unity for upland and zero for swamp. X1 is size of farmland (ha); X2 is family labour (mandays); X3 is hired labour (mandays); X4 is other inputs (N) (planting materials and other expenses like seeds, fertilizer, agro chemicals, etc); X5 is capital inputs (N) (depreciation charges on farm machinery, implements and tools, interest on loan, land rent); X1D, X2D, X3D, X4D, X5D are the slope shift dummies for farmland, family labour, hired labour, other inputs and capital inputs respectively. Ai (i = 1, 2 ,…, 5) is the coefficient of the ith variable and ei is the stochastic error term assumed to satisfy all the assumptions of the classical linear regression model.

If the coefficient of the dummy variable, D (in the additive form) is significant, it means that there is a difference in the technical efficiency of the farmer groups. If it is positive, this implies that the production function for rice farmer groups denoted as unity has larger intercept term denoting a higher level of technical efficiency than the group denoted as zero and vice versa. If Bo = 0 and all Bi(i = 1, 2, …, 5) = 0, then the two farmer groups are represented by the same production function. If Bi = 0 but B0 ≠ 0, the two groups of farmers face neutral production function. If at least one Bi ≠ 0, the two groups of farmers are facing factor biased or non-neutral production function (Onyenweaku, 1994).

For the allocative efficiency, the Cobb-Douglas functional form was estimated for each production system. The logarithmic form of the function is given by:

$$InY = bo + b1InX1 + b2InX2 + b3InX3 + b4InX4 + b5InX5 + ei \qquad (3)$$

Where all factors are as previously defined in equations (1 and 2).

The cobb-douglas functional form of equation (3) was estimated for deriving the allocative efficiency, determined by equating the marginal value product (MVP) of the ith input to its price or marginal factor cost (MFC). That is (Onyenweaku, 1994),

$$MVPxi = Pxi \qquad (4)$$

MVPxi (i = 1, 2, …, 5) = the marginal value product of the ith input = PYfi.

fi = δQ/δXi = Marginal physical product (MPP) of the ith input. The marginal physical product (MPP) based on the double log functional form is given by

$$MPP=bi(\overline{Y}/\overline{X}) \qquad (5)$$

Where bi is the coefficient of the ith variable, Y is the geometric mean of output and X is the geometric mean of the ith variable; Pxi (i = 1, 2, …, 5) is the unit price or marginal factor cost of the ith input and PY is unit price of output. According to Onyenweaku (1994) and Nwaru (2003), for all the resources measured in physical terms, the allocative efficiency index, Wij, for each farmer type is given as:

$$\frac{MVPxi}{Pxi} = \frac{PYfi}{Pxi} = Wij \qquad (6)$$

Where i, is a particular resource, j is the farmer group and all other variables are as previously defined. For any resource that is measured in monetary or value terms, the unit input price becomes irrelevant and equation (5) translates to:

$$MVPxi = PYfi = Wij \qquad (7)$$

In this study, the dependent variable, Y, was measured in physical terms while other inputs and capital inputs were measured in value or monetary terms. Accordingly, the marginal value products of the resources measured in value terms are directly equal to their allocative efficiency indices. This is because the marginal value products were already deflated by the unit factor prices since the value of these factors are the products of the quantity employed and the unit factor prices.

Maximum or absolute allocative efficiency for a particular farmer group is confirmed with respect to a given resource if Wij = 1. The resource is over-utilized if Wij < 1 and under-utilized if Wij >1. The farmer groups would have achieved equal allocative efficiency if Wi1 = Wi2. To show the extent to which a particular resource should be increased or reduced from the current level of use in order to achieve maximum allocative efficiency, we evaluate the following formula: Kij = (1-Wij)100 (8)

Where Kij is the percentage by which the level of use of a particular resource should be increased or decreased to achieve the objective of maximum allocative efficiency. A negative Kij implies that an increased employment of the resource is required and vice versa. If Kij = 0, then absolute allocative efficiency has been achieved.

The analysis of variance was used to test the significance for the mean output of rice from the production systems. It is given by:

$$Fcal = \frac{\{\sum nj(\bar{Y}j-\bar{Y})2\}/(K-1)}{\{\sum\sum(Yji-\bar{Y}j)2\}/(N-k)} \quad (9)$$

where, $\{\sum nj(\bar{Y}j-\bar{Y})2\}/(K-1)$ = estimated variance from "between" the mean,
$\{\sum\sum(Yji-\bar{Y}j)2\}/(N-k)$ = estimated variance from "within" the samples, Y = mean output from the jth production system

$\bar{Y}$ = mean output from the production systems (pooled sample mean)
Yij = individual output of the farmers in the jth production system
K = number of production systems
nj = number of farmers in the jth production system
N = $\sum$nj = total number of farmers

Decision rule: If Fcal < Ftab, accept the null hypothesis i.e we accept that the means are not significantly different, otherwise reject the null hypothesis.

RESULTS AND DISCUSSION

Technical efficiency of upland and swamp rice farmers

The estimated production function of the upland and swamp rice farmers is presented in Table 1. The intercept, hired labour, other inputs, capital inputs, intercept shift dummy, slope shift dummies for farmland and capital are significant at 1 percent; farmland is significant at 5 percent while slope dummies for other inputs and hired labour are significant at 10 percent. It has an R2 value of 0.9525 which implies that 95.25 percent of the variation in output is explained by the independent variables.

That the coefficient of the intercept shift dummy is statistically significant at 1 percent implies that a shift in technology exists between the upland and swamp rice farmers. The positive sign of this coefficient implies that there is a shift in neutral technical efficiency parameter to a higher level for the upland rice farmers. This group of farmers has therefore achieved higher technical efficiency. This conclusion conforms to the findings from Onyenweaku (1994) and Nwaru (2003).

The slope shift dummies for farmland, hired labour, other inputs and capital inputs are statistically significant, implying a difference in the slope shift coefficients of these resources. This means that the upland and swamp farmers are characterized by factor-biased or non neutral production functions. Hence, both groups of farmers are characterized by different production functions. Furthermore, the slope shift dummies for other inputs and capital inputs are negative which implies a higher level of use intensities of these resources by the swamp rice farmers while those for farmland, family labour and hired labour are positive indicating lower use intensities of the resources by the swamp rice farmers. The implication is that the swamp farmers can improve on their performance by increasing their level of use intensities of other inputs and capital inputs and reducing their level of use intensities of farmland, family labour and hired labour.

Technical efficiency inland valley and swamp rice farmers

The estimated production function for the inland valley and swamp rice farmers are summarized and presented in Table 2. The coefficient of multiple determination (R2) was 0.9146 which implies that 91.46 percent of the variation in rice output, is accounted for by the independent variables. The F–ratio is significant at 1 percent which attests to the overall significance of this estimated function. Farmland, hired labour, other inputs and capital inputs were significant and positive. The implication is that increase in their utilization would lead to increase in rice output. The intercept dummy is statistically insignificant implying that no shift in technology exists between the inland and swamp rice farmers. Both groups of farmers have equal technical efficiency and have the same production function.

Table 1: Estimated production function for the upland and swamp rice farmers

Variable	Parameter	Coefficient	t-ratio
Intercept	A0	-1.719	-4.57***
Farmland	A1	0.057	2.40***
Family labour	A2	0.007	-0.36
Hired labour	A3	0.092	3.47***
Other inputs	A4	0.174	3.49***
Capital inputs	A5	0.832	13.11***
Intercept dummy (D)	B0	7.765	7.60***
(Farmland)D	B1	0.783	6.76***
(Family labour)D	B2	0.019	0.30
(Hired labour)D	B3	-0.078	-1.67*
(Other inputs)D	B4	-0.127	-1.84*
(Capital inputs)D	B5	-0.767	-6.79***
	R2		0.9525
	R-2		0.9463
	F-ratio		153.20***

Source; Survey data, 2005.
***, **, * = Statistically significant at 1, 5 and 10 percent respectively.

Table 2: Estimated production function for inland valley and swamp farmers

Variable	Parameter	Coefficient	t-value
Intercept	A0	-1.719	-3.53***
Farmland	A1	0.057	1.85*
Family labour	A2	-7.20E-3	-0.28
Hired labour	A3	0.092	2.68***
Other inputs	A4	0.174	2.70***
Capital inputs	A5	0.832	10.12***
Intercept dummy (D)	B0	1.310	1.28

(Farmland)D	B1	0.216	2.75***
(Family labour)D	B2	0.047	1.17
(Hired labour)D	B3	-0.045	-0.86
(Other inputs)D	B4	0.497	4.19***
(Capital inputs)D	B5	0.719	-7.37***
	R2		0.9146
	R-2		0.9041
	F-ratio		86.67***

Source: Survey data, 2005
***, **, * Statistically significant at 1, 5 and 10 percent respectively.

Technical efficiency inland valley and upland rice farmers

The estimated production function for the inland and upland rice farmers is presented in Table 3. The intercept shift dummy is statistically significant at 1 percent implying that a shift in technology exists between the inland valley and upland rice farmers. Moreover, the intercept dummy has a negative coefficient.

Table 3: Estimated production function for upland and inland valley farmers

Variable	Parameter	Coefficient	t-value
Intercept	A0	6.047	5.14***
Farmland	A1	0.840	5.99***
Family labour	A2	0.011	0.16
Hired labour	A3	0.013	0.28
Other inputs	A4	0.048	0.81
Capital inputs	A5	0.065	0.56
Intercept dummy (D)	B0	-6.455	-4.43***
(Farmland) D	B1	-0.567	-3.62***
(Family labour)D	B2	0.029	0.37
(Hired labour)D	B3	0.031	0.49
(Other inputs) D	B4	0.624	5.58***
(Capital inputs) D	B5	0.048	0.38
	R2		0.9129
	R-2		0.9001
	F-ratio		71.45***

Source: Computed from Survey data, 2005
***, **, * statistically significant at 1, 5 and 10 percent respectively.

The slope dummies for farmland and other inputs are statistically significant at 1 percent. This means that the inland and upland farmers are characterized by factor biased or non neutral production functions. There is a lower level of use intensity of farmland by the inland valley farmers and higher use intensities of family labour, hired labour, other inputs and capital inputs by them. The result shows that ample opportunities exist for the farmers to increase their productivity and income through improvements on their technical efficiency. This can be achieved by putting in place policies that will enable them to increase their use of those resources currently at lower levels of use intensities and vice versa.

Allocative efficiency of the farmers in the production systems

The estimated production functions of the inland valley, upland and swamp farmers were summarized and presented in Table 4. This Table indicates that 84.69 percent, 96.10 percent and 94.71 percent of the variations in rice output in inland valleys, upland swamp farms respectively were explained or accounted for by the independent variables. The F – ratio is significant which attests to the overall significance of the regression result. This implies that the data fit the model and that the independent variables are important explanatory factors of the variations in rice output. All the variables were significant for the upland farm while farmland, other inputs and capital were significant for the inland valley rice farmers. Only hired labour was insignificant for the swamp rice farmers.

Table 4: Estimated production functions for the three group of rice farmers

Variable	Parameter	Inland	Upland	Swamp
Intercept	A0	-0.409	6.046	-1.632
		(-0.39)	(7.53)***	(-4.50)***
Farmland	A1	0.273	0.840	0.064
		(3.27)***	(8.78)***	(2.79)***
Family labour	A2	0.040	277.641	-0.011
		(1.11)	(2.07)**	(-0.53)
Hired labour	A3	0.044	645.651	0.106
		(0.88)	(3.88)***	(4.25)***
Other inputs	A4	0.672	735.412	0.221
		(5.83)***	(2.21)**	(4.41)***
Capital inputs	A5	0.112	3385.920	0.764
		(1.84)*	(8.62)***	(12.98)***
	R2	0.8469	0.9610	0.9471
	R-2	0.8278	0.9554	0.9435
	F-ratio	44.27***	172.38***	261.38***

Source: Survey data, 2005. Figures in parenthesis are the t-ratios

***, **, * = Statistically significant at 1, 5 and 10 percent respectively.

From the coefficients in Table 4, the allocative efficiency indices were derived and presented in Table 5. This Table depicts that none of the three farmer groups achieved absolute allocative efficiency in the use of farm resources. The upland farmers are the least allocatively efficient with respect to all the farm resources. This farmer group under-utilized all the farm resources; that is they used less than the profit maximizing level. The inland valley rice farmers achieved their best allocative efficiency in the use capital inputs while the swamp farmers achieved their best allocative efficiency in the use of hired labour. The inland and swamp rice farmers under-utilized farmland, other inputs and capital. The swamp rice farmers over-utilized hired labour. To achieve maximum allocative efficiency and hence maximum profit, policies and programmes that would enable the inland farmers increase their use of farmland, other inputs and capital inputs by 978.3 percent, 655.0 percent and 188.9 percent respectively should be put in place. Such policies and programmes should help the upland farmers to increase their use of farmland, family labour, hired labour, other inputs and capital inputs by 3097.2 percent, 186950.6 percent, 497751.6 percent, 734588.9 percent and 9257077.5 percent respectively. It should equally enable the swamp farmers to increase their use of farmland, other inputs and capital inputs by 163.9 percent, 159.2 percent and 2424.8 percent respectively and reduce their use of family and hired labour by 107.5 and 152 percents respectively.

Table 5: Allocative efficiency indices of the farmer groups

Farmer group	Inland valley	Upland	Swamp
a) Marginal physical product (MPP)			
Farmland	336.982	999.132	82.463
Family labour	2.281	9742.22	-0.392
Hired labour	2.435	25929.769	4.419
Other inputs	0.081	78.826	0.027
Capital inputs	0.038	993.218	0.263
b) Price of milled rice (N/kg)	96	96	96
c) Marginal value product (MVP) (N)			
Farmland	32350.272	95916.672	7916.448
Family labour	218.976	935253.12	-37632
Hired labour	233.76	2489257.824	424.224
Other inputs	7.776	7567.296	2.592
Capital inputs	2.976	95348.928	25.248
d) Marginal factor cost (MFC) (N)			
Farmland	3000	3000	3000
Family labour	500	500	500
Hired labour	500	500	500
Other inputs	1.03	1.03	1.03
Capital inputs	1.03	1.03	1.03
e) Allocative efficiency indices (AEI)			
Farmland	10.783	31.972	2.639
Family labour	NS	1870.506	NS
Hired labour	NS	4978.516	0.848
Other inputs	7.55	7346.889	2.517
Capital inputs	2.889	92571.775	24.513
f) Required change in AEI			
Farmland	-9.783	-30.972	-1.639
Family labour	NS	-1869.506	NS
Hired labour	NS	-4977.516	0.152
Other inputs	-0.562	7345.889	-1.517
Capital inputs	-1.889	92570.775	-23.513

Source: Survey data, 2005. NS = not significant

Returns to scale of the farmers in the production systems

The elasticity of production for the farmers in the production systems from which their returns to scale were derived are presented in Table 6. It shows that none of the defined farmer groups is operating at constant returns to scale. Farmers in the different production systems are operating at increasing return to scale ($\sum Ep>1$), suggesting that they are operating in region one of the total product curve which is an irrational region to rest production. The implication is that they can improve on their productivity by increasing their overall employment of farm resources.

Table 6: Elasticity of production of the farmers based on the production systems

Variable	Inland	Upland	Swamp
Farmland	0.273	0.840	0.068
Family labour	0.040	277.641	-0.011
Hired labour	0.044	645.651	0..106
Other inputs	0.671	735.412	0.221
Capital inputs	0.112	3386.920	0.764
∑Ep	1.14	5046.464	1.148

Source: computed from survey data, 2005

Mean output of rice from the production systems

The test of significance in the mean output of rice from the production systems was realized through analysis of variance (ANOVA) and the result is presented in Table 7. The table revealed the calculated F – value was 2.074 and the tabulated value, 3.00. Therefore, since the calculated F- value was less than the tabulated value (Fcal < Ftab), the null hypothesis is accepted. Hence there is no significant difference in the mean output of rice from the various production systems.

Table 7: ANOVA test of significance in the output of rice by production systems

Source of Variation	Degree of Freedom	Sum of squares	Mean Square	F cal	F tab
Between	2	9187012.42	4593506.21	2.074	3.00
Within	139	307858775.60	2214804.86		
Total	141	317044888			

Source: Survey data, 2005.

CONCLUSION

Results indicate that the upland rice farmers are technically more efficient than the swamp and inland rice farmers and that there is no difference in technical efficiency between the swamp and inland rice farmers. Furthermore, resources were poorly allocated by these rice farmers in each of the production systems: inland valleys, upland and swamp environments. None of the farmer groups achieved absolute allocative efficiency. There was no significant difference in the mean output of rice from the production systems; upland, inland valley and swamp while each operated in region one on the production surface indicating that overall, resource levels could be increased to achieve higher levels of productivity in each system.

Therefore, economic policies and programmes that could encourage the reallocation and if possible the redistribution of farm production inputs for increased farm productivity and efficiency should be put in place. Such policies should be appropriate enough to grant rice farmers increased access to farmland. They should enable them employ the use of more farm resources since there is increasing return to scale, be targeted more at the upland rice farmers and seek opportunities for exploring the swamp and inland valleys more.

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