ANALYSIS OF TECHNICAL EFFICIENCY OF RICE FARMS IN DUKU IRRIGATION SCHEME KWARA STATE, NIGERIA

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ABSTRACT

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This study estimated the technical efficiency and the cost and returns of rice farms in the Government irrigation scheme located at Duku area of Kwara State, Nigeria. It also identified the determinants of the technical efficiency. The average gross margin of the rice farms is ₦94, 376.35. The rate of returns to the rice production 88.8%, which indicated that for every ₦ 1 invested in each of the sites ₦0.88K, was expected as profit respectively. The technical efficiency was estimated using the Cobb-Douglas Stochastic frontier Production Function. The result revealed the mean technical efficiency of the project sites (Rice Farm) is 0.98. The high efficiency estimate obtained for the rice farms at the project site can be attributed to the government assistance to the farmers in the form of input/output linkages. It is therefore the recommendation of the researchers that High Yielding Rice Cultivars, credits and other forms of institutional supporting project should be the focus of government if rice productions are to be improved and sustained in this environmental change.

Keywords: Rice, Technical Efficiency, Duku Irrigation Scheme, Cost and Return

INTRODUCTION

According to the Trinity College's encyclopedia, "the Natural World" agriculture as a human activity is only about 10,000 years old. It is a miracle of modern time. For many years, predictions of calamity based on worldwide food shortages have been made, however the combined actions of farmers, scientist, industry and government in the developed countries of the world have averted crises by achieving new levels of production at each epoch. This cannot be said to hold true for developing economies like Nigeria's, as most African and indeed the other so called "third- world" countries are unable to cope with worsening food situation (Vevers, 1977). In Nigeria, agriculture plays significant roles in the nation's economic development. These roles include: contribution to the country's gross domestic product; source of income and decent living for a large proportion of the population; provision of adequate food for the people; supply of raw materials required by the industrial sector; generation of foreign exchange through export; provision of employment opportunities for the teeming population (PCU, 2002).

Out of Nigeria's estimated 69.9 million hectares of agricultural land about 39.2 million are under permanent pasture with another 2.8 million under permanent crops, leaving about 27.9 million ha for arable crops (source?). Within the last category, it is estimated that some 25 million hectares are cultivated each year implying a high cropping intensity with respect to arable land. Forestry constitutes about 26 million hectares currently. Crops contributes some 27% of GDP, livestock another 3.3% and forestry and fisheries 1.5%. A list of the country's agricultural exports include cocoa, cotton, vegetables and fruits, leather and these exports represent less than 5% of export earnings (ADB, 2004). Agriculture in Nigeria has been restricted to the small-scale level. Over seventy percent of Nigerians are engaged in small-scale farm holding yet the level of production cannot be said to be coping with level of demand. This is against the developed economies like America where about 5% only are engaged in agricultural production, yet it feeds itself with enough surpluses for export (FAO, 2001).

Since 1976, various agricultural programmes have been initiated to stem the declining fortunes in the agricultural sector. Among such programmes initiated are the Operation Feed the Nation, Green Revolution, the National Livestock Project, River Basin Development and the World Bank Assisted Agricultural Development Projects (PCU, 2002). In spite of all these laudable initiatives, the agricultural sector in Nigeria has been unable to make substantial contributions to Nigeria's Gross Domestic Product. Evidently, the advent of oil boom has been largely responsible for the relegation of agriculture to the background of our economy. The decline in the agricultural sector has had a resultant effect in our inability to achieve self-sufficiency in food production and as well source adequate raw materials for our agro-allied industries (Ayoola, 2001). Allied with the aforementioned are the new problems of rapid population growth coupled with environmental degradation that have arisen. From an overall perception, considering recent trend and current estimates of over 140 million people in Nigeria, there is cause for greater concern with respect to the little progress in agricultural development and the worsening economic and food insecurity situation (FAO, 2001). Past policy and programme efforts in Nigeria it has been noted achieved little in meeting pre-set food target (Ayoola, 2001) Therefore, future prospects will definitely depend on how adequately certain needs are satisfied and some issues attended to by the government if growth is to be achieved

the nation's agricultural sector, particularly among the small-scale holders. Hence this study examines one of the Kwara State particular interest, which is the Government's Duku-Lade Irrigation scheme, located in Lade District of Patigi Local Government Area of Kwara State.

Rice, which is of particular interest to this study, is one crop in which Kwara State has a comparative advantage as far as its production is concerned in Nigeria (Kwara state Ministry of Agriculture 2004). The major rice-producing zone of the state is the North Senatorial District, where about 20,200 hectares of land are devoted to rice only. The average yield per hectare according to Kwara ADP (2005) is put at 2.37 tonnes/hectare. This research work is therefore concerned about the technical efficiency differentials of rice farms that enjoy government patronage and those surrounding farms that do not enjoy the same privilege (Kwara Seed Document, 2003). Of particular note to this research work are the rice farms located in the Duku-Lade River Basin; an area with vast potential for rice cultivation. At this location, it has been observed that little research work has been undertaken to quantitatively study the efficiency levels of rice farms. This is particularly true of the areas currently benefiting from the current administration's intervention/assistance scheme. The study therefore examines the technical efficiency of the project farm sites under the Duku-Lade government assisted project farm sites.

High lights of kwara state agricultural programmes (2003 –2004)

Over the years, agriculture has been the mainstay of Kwara State's economy. Over 70% of the State's estimated 2.3 million (2006 census) people are actively involved in agricultural production. In spite of the good soil and favourable climatic conditions, agriculture has over the years not made substantial contribution to the revenue base of the State or to the standard of living of its people (Kwara Seeds Document, 2003). This fact must have necessitated the resolve of the current administration, on coming into office in the year 2003, to initiate a number of programs, all geared towards improving the level of Agricultural Production in the state. Some of the programmes initiated include:

(i) The Molete Integrated Youth Farming Schemes, which was designed to create a successor generation of farmers in the state. The scheme sought to ease drudgery in farming and make it attractive and lucrative for educated youths and other interested in farming.

(ii) The Duku-Lade Farm Site, where government made available and at affordable prices, farm inputs like fertilizer, improved rice seeds, pesticides and herbicides etc. Irrigation and tractor support, as well as some form of strengthened and expanded extension/advisory services were also made accessible at this location.

In each of the 3 Senatorial Districts of the state, Cassava Processing Centers were established to take care of harvested cassava crops, with a view to enhancing its storage and market acceptability.

(iii) An enabling environment for big time commercial farmers was encouraged. The first major foreign investment in the agricultural sector in Kwara was that by the New Nigeria "Zimbabwe" Farmers at Tshonga. They began operation three years ago. Between the ten "foreign" farmers, 1687 hectares of land was cultivated. Crops grown by the farmers range from grains like maize, cowpea, Soya beans, groundnut to root tuber like cassava. To assist them effectively take-off, the government provided them with incentives like land, necessary infrastructure facility and the guarantee for obtaining bank loan. Similar gesture was extended to the proprietors of "Coga" Commercial Farms. Some indigenous entrepreneurs are behind the establishment of the Coga Farms. Their area of concentration is on cassava production. They have plans to establish a factory, which will use the harvested cassava as raw material in the manufacture of ethanol (Kwara State Ministry of Agriculture 2004).

METHODOLOGY

The study area was Kwara State. Kwara State was created in May 1967. It comprises of 16 Local Government Areas with a population estimate of about 2.3 million people (2006 census). The State shares boundaries with Oyo, Ondo and Osun to the South, Kebbi and Niger to the North, Kogi to the East and Republic of Benin on the West side. The daily temperature ranges between 21°C to 33°C. The state has two distinct climate seasons, the wet (Rainy) and the Dry (Harmattan) seasons (KWARA Ministry of Agriculture 2004). The rainfall pattern across the state extends between the months of March to October with a short break in August, while the dry season falls between November and February. These climatic conditions as well as fertile soil make the state favourable for arable crop production such as rice, millet, yam, cowpea etc.

This study was conducted in Patigi Local Government Areas, in the ecological zone B of the state. The study is restricted to the rice farms located in the Duku River Basin. Data was available for the 2006 wet season at the two farm sites under consideration. Data was also secured for some farmers who took part in the 2005 dry season farming at the project site as well. The data used in this study were obtained from both primary and secondary sources of information. Information related to primary data were sourced through the help of KWADP enumerators with the aid of interview schedules. Secondary data were obtained via excerpts from newspapers, photograph, journals, the Internet, the planning, monitoring and evaluation (PME) department of KWADP, the State and Federal Ministries of Agriculture. The data collected was based on the 2005 dry and 2006 wet cropping

season. The data collected covered the socio-economic characteristics of selected farmers, agricultural production and other economic indicator variables. Socio –economic and demographic data collected include those of age, experience, gender, household size, educational status, source of credit facility, while agricultural data included farm size, access to farm inputs, labour utilization among other factors.

Benefiting directly from the Duku-Lade Government assisted farm site are some 600 Farm Families. For the purpose of this study the 600 Farm Families formed the sampling frame out of which a random selection of 12% i.e. 72 Farm Families was made. Each farm family in the sampling frame was assigned a number, and then 72 farm families were chosen using a table of random numbers and eventually only 62 farm families responded.

Analytical techniques

The analytical techniques employed in the study include: Descriptive Statistics, Farm budget analysis and stochastic frontier.

Farm Budget Analysis

Partial budget analysis was employed to determine Net Farm Income (NFI) and the Returns to Farmer's Labour per hectare derived from rice production in the study area. The model for estimating the farmer's returns to labour and management is outlined thus:

Gross Value Output (TR) -Total Variable Cost of Production (TVC) = Gross Margin-----(1)

Gross Margin -Fixed cost = Net farm income ----------(2)

Net farm income - Imputed cost of Family labour =

Returns to Farmer's Labour and Management…….(3)

Returns to Farmer's Labour and management/Net Farm Income are the focal point for the costs and returns analysis of this study.

Rate of return (ROR) provides a measure of financial performance of the enterprise employed expressed in percentage (%) (i.e. profit/ ₦ invested)

Stochastic Frontier Functions

The stochastic production frontier model was also used. Since stochastic frontier production models proposed by Aigner, Lovell and Schmidt (1977) and Meeusen and vanden-Broeck (1977), there has been a vast range of their applications in literature. Battese and Coelli (1995) proposed a stochastic production function, which has firm's effects as a truncated normal random variable, in which the inefficiency effects are directly influenced by a number of variables. The generalized stochastic frontier model can be expressed for the rice farm sites as: $Q = f(X_I, X_2, X_3, X_4, X_5, X_6, X_7, e)$----------(4)

Applying the Cobb-Douglas production function

$$\ln Q_{ip} = ß_0 + ß_1 \ln (X_{1p}) + ß_2 \ln (X_{2p}) + ß_3 \ln (X_{3p}) + \beta_4 \ln (X_{4p}) + \beta_5 \ln(X_{5p}) + \beta_6 (X_{6p}) + \beta_7 \ln (X_{7p}) + (V_{ip} - U_{ip})$$ ----------(5)

Where:

(i_p =1…62); Q = Output in kg; X_1 = land (Ha); X_2 = Labour in Man-day X_3 = Fertilizer (Kg); X_4 = Seeds (Kg); X_5 = agrochemicals (Litres); X_6 = Equipment (number); X_7 = Tractor usage (machine day); In = Natural Logarithm (i.e. Log to base e); $ß_I$'s= unknown Parameters to be estimated

According to Aigner, Lovell and Schmidt (1977), the error term is really a composite of two terms:

$\varepsilon = V_i - U_i$; i =1,…,n ----------(6)

Where Vi represents random variables that are assumed to be normally distributed $N \sim (o, \delta_v^2)$ and independent of the Ui. It is assumed to account for measurement error and other factors not under the control of the farmer. Vi is the two-sided normally distributed random error [$(V \sim N (o,\sigma^2)$].

-Ui represents non-negative random variables called technical inefficiency effects which are assumed to account for technical inefficiency in production and are often assumed to be normally distributed $N \sim (0, \delta_u^2)$. Ui is the one-sided efficiency component with a half normal distribution $U \sim [N (o, \sigma^2)]$.

Knowing that firms are technically inefficiency might not be useful unless the sources of the inefficiency are identified (Admassie and Matambalya, 2002). Thus, the second stage of this analysis investigates the sources of the farm level technical inefficiency for the project.

The inefficiency model for the two study sites are assumed thus:

$U_{ip} = d_{op} + d_1 Z_{1p} + d_2 Z_p + d_3 Z_p$ ----------(7)

Where: U_i = Technical inefficiency; Z_1 = Years of experience of farmers (years); Z_2 = Level of education (years); Z_3 = Household size; Z_4 = Access to irrigation site (Yes = 1, No = 0); Z_5 = Access to former credit (Yes = 1, No = 0); Z_6 = Membership of cooperative association (Yes = 1, No = 0)

The maximum likelihood estimates will be adopted because according to Coelli (1995), it is asymptotically more efficient than the corrected ordinary least square estimates. The maximum likelihood estimates for all the parameters of the stochastic frontier and inefficiency model, defined by equation (1) and 2 will be simultaneously obtained by using the program, FRONTIER VERSION 4.1. (Coelli, 1996) which estimates the variance parameters in terms of the parameterization.

$\delta^2 = \delta V^2 + \delta U^2$ ---------- (8)

and $\gamma = \frac{\delta U^2}{\delta V^2 + \delta U^2}$ ----------(9)

Where gamma (γ) = total output attained on the frontiers which is attributed to technical efficiency. Hence, it is a measure of technical efficiency. The technical efficiency of a farmer is between 0 and 1 (Battese an Coelli, 1995) and is inversely related to the level of the technical inefficiency effect.

Similarly, (I – Y) measure the technical inefficiency of the farms. The estimated Lambda (λ) is expected to be greater than one. Such a result indicate a good fit for the model and the correctness of the specified distribution assumption for V_i an U_i

RESULTS AND DISCUSSION

Age is one of the determinants of productivity of the farmer in agricultural production. Age is particularly important considering the tedious nature of manual land preparation and weeding (Babatunde, 2003) At the project site, analysis on age reveals that the modal age group is 31 – 40 years with 58% of the 62 respondents in this age group. The mean age of the resource users is 35.5years. The relative preponderance of youths in farming, particularly at the project site, is a negation of the popular belief that the farming population is aging in most Nigerian rural communities, indicating perhaps that the life expectancy age of the rural folks is falling below the mark.

It is also worthwhile to note that 100% of the respondents are male. Land ownership, which is by inheritance, is principally along the male lineage. The male being the head of the family is usually vested with the owner ship of the family land. At the project site, it appears women have not been sensitized enough to take part in the government assisted Duku-Lade Rice Farm Scheme. Reasons that can be attributed to the marginalization of women in land ownership and not having direct access to rice fields is probably the cultural/religious leanings of people in the study area. The prejudices are there, with little evidence of changes. However intensive education and government intervention can go along way in narrowing this obvious gap between the male and female participation in rice farming in the study area.

An individual in the family is potential source of labour on the farms. The modal group of family size is 1 – 5 persons at the project site, which constitutes 51%. The average size of farm family at the project site is about 3 persons. Probably because of the harsh economic environment, most families are hereby keeping low the number of children and thereby having smaller family size against the find of other authors such as Ayinde et al (2010). Education and literacy help to eradicate ignorance and promote adoption of innovation (Adewumi, 2007). About 50% of the respondents at the project site possess no formal education. A priori expectation is that farmers with more years of experience are expected to be more knowledgeable and effective in farming operations. Experience it is often repeated is the best teacher. However, some others hold the contrary view that it is not how far, but how well a firm/farm is efficiently managed. A typical farmer at the project site had 15years of experience in farming. The farmers at the project site indicated that they have been involved at the project site over the 2005 and 2006 farming season. The project came into being in the year 2005. The modal class for farming experience in the project site is 11 – 20 years. Virtually all respondents at the project belong to one form of socio-economic organization or the other. Cooperative Organization affords members the advantage of benefits accruing to members. This was evident in the case of project sites farmer who have to belong to a cooperative organization before they could be accessing benefit of project farms, which in somewhat affected their technical efficiency of production positively.

Of the 62 respondents at the project sites 82.26% belong to agricultural cooperative societies respectively. At the Project site, 64.52% of all the farmers acknowledged they do have other sources of income aside from farming. This perhaps suggest that the project site farmers have considerable time to attend to other activities as side there farming, and thereby bolstering their income and affording a higher standard of living.

The study revealed close to 100% of the 62 respondents at the project site enjoy Government support in the area of land preparation, input procurement, farm produce, marketing, crop management and extension service/training provision. It is also worthy to note the irrigation scheme site which was rehabilitated for a use in the 2005 dry season cropping was of no use during the 2006 dry season, as a result of the collapse of headwork and silting up of the river channels.

Analysis of costs and returns to rice production

Table: 1 Summary of Costs and Returns to Production of One Hectare of Rice Farm

Description	Project Site Mean Resource Use/Ha
Labour input (ha)	89.14 man-day
Gross Income/ha	197,798.92
Less TVC:	
Labour Cost (₦)	56,618.55
Seed (₦)	4,873.66
Fertilizer (₦)	14,449.35
Herbicides (₦)	994.62
Machine Cost (₦)	26,486.49
Total Variable Cost (₦)	103,422.67
Equals Gross Margin (₦)	94,376.25
Less Fixed Cost (₦)	2,907.61
Equals Net Farm Income (₦)	91,468.64
Less Imputed Farmer's Family Labour	56,618.55
Returns to Farmer's Labour & Management	38,850.09
Rate of Returns to Rice Production (%)	88.8

(Source: field survey, 2006)

Variable cost

Variable cost includes the costs of fertilizer and other agro-chemicals.

Value of family labour

Value of family labour was obtained by assuming its opportunity cost to be equal to the prevailing wage rate since family and hired labour are assumed to be perfect substitutes.

Capital cost

The Capital cost is the depreciated value of farm, implements.

The gross margin of ₦94, 376.35 appear to be economically viable The rate of returns to rice production at the project sites was estimated at 88.8% which indicate that for every ₦ 1 invested in the sites ₦ 0.88k was expected as profit.

Determinants of technical efficiency

The statistics gamma (γ) obtained from the estimated MLE model had values of 0.62 at 5% significant level. The result revealed the mean technical efficiency of the project sites (Rice Farm) is 0.98. The high efficiency estimate obtained for the rice farms at the project site can be attributed to the government assistance to the farmers in the form of input/output linkages.

The results of the estimated maximum livelihood coefficient for both seeds and herbicides/pesticides (Agrochemical inputs) indicate positive value of 6.037 for seeds, 7.809 for chemical inputs in project sites were significant at 5% level. Consequently, an increment of the seeds for project site farms by one percent will increase output by 6.037 percent. Perhaps, the access to improved rice varieties must have led to the obvious higher yield per hectare of rice cultivated at the project site. This result is consistent with that of Okoruwa and Ogundele (2006) which indicated quality of seed planted was more important than absolute quantity.

The study also found out an incremental of the chemical inputs (herbicides/pesticides) will increase output by 7.809 percent. The study also revealed that machine use in project sites has significant positive value of 7.914% increment in output, suggesting the project site farmers patronize the use of machine. Contrarily, the estimated MLE coefficient of land, labour and fertilizer in project sites showed significant negative values of –6.018, -2.133, and -5.883 respectively. This indicate an inverse relationship between the inputs and the output obtained i.e. an increment of the input by 1% will reduce the total output by their corresponding values in percentages. Also, akin to the findings of Okoruwa and Ogundele (2006) is the realization that over utilization of labour and fertilizer input did not suggest that increased uses of these inputs would yield more than proportionate increase in output.

Determinants of technical inefficiency

The coefficient of years of experience for project site farms had positive value and significant at 5% level, which indicates a non-correlation between the years of experience and the production activities. The level of education coefficient showed negative but significant value at 5% level, therefore, the more education the farmers had, the more efficient they become and the higher the production efficiency. The sign of the coefficient of age of the household heads was negative for the much younger project site farmers. This shows that the household head probably, require, also a more sophisticated physical skill,

The dummy variable for access to project site was negative and significant at 5% level indicating that access to project could increase output level by virtue of the incentives given by the government.

The access to credit variable is expected to have a negative effect on the efficiency and so its coefficient, expected to have a positive value, hence the negative values for the variables obtained. Though, lack of access to credit may deprive the farmer from the purchase of inputs to increase efficiency. The coefficient of the dummy variable for access to co-operative association was negative indicating that the more farmers have access to co-operative the more informed they are and the more efficient they become in their production tasks.

CONCLUSION

The study revealed majority of the respondents in the project sites belong to the co-operative organization. Respondents at the project sites used tractor and human labour. The study also revealed that majority of the farmers in the project site received various assistances. Virtually all the farmers in the project sites hired their tillage equipment from the government. The farmers in the project sites obtained their farm inputs in form of the kinds from government and through personal income. The result of the farm budget analysis revealed that farms from the project sites are profitable and the rate of returns (ROR) to rice production showed that the ROR is high. The result of the estimated maximum likelihood coefficient indicates that seed agrochemical and machine in project sites, showed significant positive value at 5% level. Thus a 1% increment in these input will increased output by their corresponding coefficient in percentage. The outcome of the determent of technical inefficiency showed that education access to project, co-operative and age in project sites had significant negative value at 5% significant level. Thus have positive effect on the technical efficiency of the farms.

RECOMMENDATIONS

Given to the significance of fertilizer and improved High Yielding Cultivars (HYC), it is recommended that design policy framework that will ensure the sustainable provision of these two inputs so as to enhance efficiency and competitiveness in production be encouraged and put in place. Government, cooperative bodies, and private organizations should create a support system by the establishment of a number of one-stop shops at convenient locations; so that farmers can easily access fertilizer and other farm inputs. It is therefore not out of place for governments in Nigeria to subsidize farm inputs, if production is to be increased. However, the technical efficiency indices will be estimated outside of the actual market price of farm inputs. For the Kwara State Government, that has been giving price-based-support to the New-Nigeria "Zimbabwe" Farmers, it will also be worthwhile if it gives some leverage to local farmers as well. What is good for the goose is also good for gander.

It is recommended also that government should restructure its current position on the Dry Season Irrigation Projects to make it more efficient and effective. Considering the fact that large scale production during dry season can not be easily sustained in terms of hecterage, water sourcing, sufficient farmer's participation, labour requirement for bird scaring etc., all the more calls for these restructuring. The small present cultivation level during the dry season, more often result in the problem of "farm isolation" thereby exposing these lonesome farms to vagaries of insects and other pest's devastations. Therefore Government cannot but pay greater attention to rain fed rice farming. Through the provision of HYCs and other necessary farm inputs, the much desired increased production levels as well as efficiency of production can be attained. After all, in spite of the enormous amount expended on the existing Duku Lade Irrigation site facilities, it became non-functional barely one year after its rehabilitation. So, funds should rather be channeled towards rain fed cropping season. The existing flood channel will still be useful, as basin irrigation is the main practice in place, both during the dry and raining season at the study site.

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Table 2: The finale maximum livelihood estimates (MLE)

	Parameters	Coefficient	S.E.	t-Ratio
Constant	β_0	9.447**	0.886	10.654
Land	β_1	-4.887**	0.812	6.018
Labour	β_2	-0.510**	0.239	-2.133
Seeds	β_3	1.498**	0.248	6.037
Fertilizer	β_4	-2.916**	0.496	-5.883
Agrochemicals	β_5	4.551**	0.583	7.809
Equipments	β_6	0.060	0.089	0.675
Machine	β_7	2.296**	0.290	7.914

Significance Level of 5% and 10% are indicated by ** and * respectively.
Source: Field Survey 2007

Table 3: Determinants of technical inefficiency

		Coefficient	S.E.	Ratio
	Δ_0	-0.019	0.818	-0.023
Experience	Δ_1	0.020**	0.008	2.407
Education	Δ_2	-0.290*	0.177	-1.638
Household	Δ_3	-0.027	0.022	-1.235
Access to Project site	Δ_4	-0.240**	0.070	-3.406
Credit	Δ_5	-0.019	0.818	-0.023
Cooperative	Δ_6	-0.019	0.818	-0.023
	$_2\delta$	0.014**	0.004	3.261
	γ	0.617**	0.112	5.476
Log Likelihood Function		71.729		

Note: Significance Level of 5% and 10% are indicated by ** and * respectively.
Source: Field Survey, 2007.