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EFFICIENCY ANALYSIS OF CEREAL -LEGUME BASED CROPPING SYSTEM IN KACHIA AND KAGARKO LOCAL GOVERNMENT AREAS OF KADUNA STATE

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Abstract

The study was to examine the level of resource used efficiency in cereal legume base cropping system in Kachia and Kagarko Local Government Areas of Kaduna State. A multi stagesampling procedure was use, the random sampling techniques was employed for the selection of a total of 150 farmers who were interviewed through the used of structured questionnaire aimed to captured the objectives of the study. Data were analysed with the use of descriptive statistics and stochastic production function. Findings from the results shows that the major cereal legume combination observed in the cultivated farmer's plots in the area were maize and soya bean, sorghum and groundnut maize and groundnut, maize and soya bean and sorghum and soya bean in the respective order. Farmers were relatively efficient in the used of the production resources and technology at their disposal, with seed and fertilizer as the most significant resources which affects the efficiency of the cereal legume production. Age and house hold size were the most significant socio economics variables that affects inefficiency of production in the study area.

Keywords: Stochastic, Production, frontier, efficiency, Cereal, Legume.

INTRODUCTION

Agriculture still occupies a key position in Nigeria's economy. Over 70 percent of the population resides in the rural areas and earn their living from agriculture (Ogungbile and Olukosi, 1991). Agriculture plays an important role in employment and revenue generation as well as in the provision of raw materials for industrial development. The sector holds the key to rapid economic transformation, poverty alleviation, stable democracy and good governance (Rahman,2008). However, the nation's agricultural potentials are far from being fully realized and this has serious implications for food security and sustainable economic development.

The under-development of agriculture is, indeed worrisome, given the fact that the country is naturally well endowed for agricultural production. According to Azeez (2002), a large percentage of Nigeria population derived their income from agriculture and agriculture related activities in which 75% of its rural inhabitants are farmers.

However over the years, the of rate growth in agricultural production has stagnated and failed to keep pace with the needs of rapidly growing population, resulting in a

progressive rise in import bills for food. The gap between population and food supply continues to widen (CBN,2005).

Nigerian agriculture has suffers greatly from low funding. Research has shown that most of the farmers are Small Scale and poor (World Bank,2006). Because of this poverty they cannot adopt improved technologies such as fertilizers, herbicides, improved variety of seeds and modern farm machinery such as tractors and combined harvesters. They use traditional tools that are capable of generating only a very small income. They produce primarily for consumption (Rahman, et al. 2002; Imonke, 2003).

Farmers attitude towards risk and uncertainty is one of the major factors, which influence farm production decisions with respect to cropping pattern, and the use of technology. Cereal-legume mixtures are most common type of intercropping practice by most farmers in the Northern Nigeria and this may due to the possible benefits the cereal can derived from legume (Rahman, 2001). The systems facilitate adequate utilization of resources such as land, labour and capital, but the interpretation of crop performance in terms of resource productivity becomes complicated.

Cereal- legume mixture is the most popular mixed cropping in Northern and middle belt zones of Nigeria. This is due to the beneficial impact of legumes on the cereals such as provision of vegetation cover to check erosion as well as competitive effect of weeds on available water and nutrients (Anon, 1996). Farmers are now adopting cereal-legume mixtures in their farms one of the techniques for integrated soil fertility management for sustainable yield and steady income.

Intercropping creates more opportunity to market small surpluses of greater range of products, increasing cash income for different family members especially women (Guyer, 1986).

Intercropping of maize or sorghum with groundnut generally leads to greater production per unit area than growing the crops in pure stands (Awal ,2006). This is because there is more efficient use of resources such as light, water, soil nutrients by cropping mixtures than the same crop grown sole. It is as a result of this that farmers still cultivate crops mixtures instead of sole. In Nigeria, a large proportion of the land is devoted to mixed cropping (Olukosi and Ogungbile, 1991). The motive of the farmer's preference for mixed cropping is mostly associated with risk. There could be other factors that influence farmer's decision in favour of mixed cropping system; which are yet to be identified and understood. The nature of input-output relationship, price efficiency of inputs the technical and managerial factors influencing the decision of peasant farmers to continue in cereal-legume system is the main focus of the research.

THEORETICAL FRAMEWORK

In Nigeria, a large proportion of the land is devoted to mixed cropping (Olukosi and Ogungbile, 1991). The motive of the farmer's preference for mixed cropping is mostly associated with risk.

The cereal-legume mixture is the most common type of intercropping practice in the tropics and this may be due to the possible benefit the cereal can derive from the atmospheric nitrogen fixed by legume nodules.

It has been contested that non-legumes can acquire adequate supply of nitrogen when grown together (Anon, 1996). According to Mandal (1990), there was increase yield of maize and groundnut in a mixture of the two crops. This was attributed to the greater utilization of the environmental resources compared to when the crops are planted sole.

They also observed the same trend in maize-cowpea mixture. Enyi (1973) also reported that intercropping sorghum with pigeon peas increase total grain yield per hectare.

In a series of mixtures of maize and several legumes in Sri Lanka, it was found that maize yield were increase by 103% with cowpea, 16 – 28% with mung bean, 16-42% with groundnut while the corresponding legume yield were all reduce (Gunasena *et al.,* 1979). Some research workers on the other hand recorded little or no advantage of cereal legume mixtures over the sole crops.

In fact, in some cases, decreased yields were reported. In a sorghum-soyabean fertilizer experiment at Samaru, Abaver (1984) reported that the presence of soyabean reduce sorghum yield by about 20%. This he concluded may be due to vigorous competition of soyabean with sorghum for mineralized soil or nitrogen fertilizer. In maize-soyabean mixture at Samaru, maize yield were not significantly affected by the presence of soyabean, but soyabean yield was reduce to 45% of the sole crop yield (Fisher, 1980). Though, the yield of a particular crop as a component in a mixture may be of some economic significance. It was reported by Rahman (1998), that millet/cowpea and sorghum/cowpea mixtures were more profitable than the sole cowpea and so the farmers preference to mixed cropping.

Most of the farmers in the northern Nigeria grow maize in mixtures with leguminous crops such as cowpea, soya beans and groundnut as observed by Rahman *et al.* (2002). Among the mixtures maize/cowpea mixture recorded the highest yield of 1168.15kg, follow by maize/ soya bean. Maize/cowpea mixture had the highest gross margin of N33, 943.20/ha, follows by maize/groundnut mixtures among all the maize cropping system in Giwa Local Government Area of Kaduna State.

Maiangwa and Rahman (1997) reported that growing cowpea in mix cropping with millet allowed farmers to maximized profit and use labour efficiently. Millet as an important source of various type of food to farmers met their family needs and may be difficult to persuade the farmers from growing cowpea and millet in mixtures.

METHODOLOGY

Study Area

The study was conducted in two Local Government Areas (LGAs) of Kaduna State, namely Kachia and Kagarko Local Government Areas. The state lies in the North Central position between latitude 9º 10 N and 11:30 North and Longitude 6º E and 9º: 10 East of the prime meridian. The state shares common borders with Katsina, Kano, Zamfara, Federal Capital Territory, Plateau, Niger and Nassarawa States.

The Area fall within Samaru Agricultural Zone with an annual rainfall varying between 1107mm and 1286mm (Ileoje,1989).

Sampling Procedure

A multistage sampling procedure was used for the study. A pre surveyed was carried out to identified Wards with higher concentration of cereal-legume farmers. The first stage involved purposive selection of 10 wards out of the 20 wards that made up the two Local Government areas (Kachia & Kagarko).

The second stage involved a random selection of one village from the wards. The third stage involved a random selection of farmers from each of the selected villages base of a proportionality factor of 10% to make up a total of 150 farmers. (That is 75 farmers from each Local Government Area).

Data Collection

Primary data were used for this study. The data were collected based on the 2011 Cropping Seasons through the use of structured questionnaire which was administered to the farmers engaging in cereal-legume mixtures.

Analytical Tools

The following tools of analysis were employed to achieve the objectives of this study.

Descriptive statistics and Stochastic production frontier

Descriptive Statistic

Data analysis was done by means of descriptive statistic such as frequency distribution table, percentage and proportions to assess the socio-economic characteristics of the farmers and the existing Cereal- legumes based farming system in the study area.

Stochastic Frontier model

The stochastic productions function as specified by (Battese and Coelli, 1995; Amaza and Olayemi, 2002) was stated as:

$Y_{it} = f(X_{it}\beta)exp(V_{it} - U_{it})$

(1)

Where;

Yit= output

X_{it} = a vector of inputs

β = a vector of parameters to be estimated

f =is the Cobb-Douglas functional form.

V_{it} =are random error that are assumed to account for measurement errors of the farm that are assumed to be independently and identically distributed $(iid), N(0, \sigma v^2)$

U_{it} = are non-negative technical inefficiency in the production and obtained by truncation (at zero) of the normal distribution with$N$ $(m_{it}, \sigma v^2.)$

Where m = $z_{it}\sigma$,

The values of the unknown parameters of this model were estimated by maximum likelihood method, after making assumptions regarding the distributions of $U_i and V_i$which are often assumed to be normal and half normal, respectively. As presented in the model, the stochastic frontier has two error terms,

$\sigma^2 = \sigma_v^2 + \sigma_u^2$(2)

and

$\gamma = \sigma_u^2/\sigma_v^2$ where, γ is defined for (0 <γ< 1) (3)

unlike in the traditional production function. One error term,U_i, accounts for technical inefficiency and the other V_i, to account for other factors such as measurement errors in the output variable. Therefore the cobb-dauglass specification is as follow;

$lnY = \beta_0 + \beta_1 l_n q_1 + \beta_2 L_n q_2 + \beta_3 L_n q_3 + \beta_4 L_n q_4 + \beta_5 L_n q_5 + V_i - U_i$(4)

Where,

L_n= Natural logarithm to base 10

Y_i = Total output of ith farm (kg grain equivalent)

$\beta_{0-}\beta_5$ = Parameters to be estimated,

q1 = Farm size (ha)

q_2 = Labour (Man-days)

q_3 = Seed (kg)

q_4 = Fertilizer (kg)

q_5= Agrochemical (litres)

Efficiency determinants:

A unique feature of the stochastic frontier is the decomposition of the component error term (Vi-Ui) into mutually exclusive events. This is usually achieved by estimating the mean conditional distribution of U given V expressed as:

$E(V/e_i) = U_i = \sigma^*[f^*\{-\mu/\sigma^*\}[1 - F(U_i/\sigma^*)^{-1}]$ (5)

Where; $\sigma^* = (\sigma v^2 \sigma u^2/\sigma^2)^{\frac{1}{2}}, \mu = (-\sigma u^2 e_i)$,

$fisthe\ standard\ density\ function\ and\ Fisthe\ distributional\ assumption.$

The values of the unknown coefficients were estimated using the maximum likelihood [ML] method.

V_1 = Random errors which are assumed to be independently and identically distributed as N (0, σ^2 v).

U_i =Non- negative random variable associated with technical inefficiency of production assumed to be independently distributed such that μi is obtained by truncation (at zero) of the normal distribution with variance σu2 and mean μ where the mean is defined by;

μ=δo+δ1z1δ1z2+δ3z3+δ4z4+δ5z5+δ6z6+δ7z7+δ8z8 (6)

Where;

δ= a vector of unknown parameters to be estimated

zi = (I = 1, 2, 3, 4, 5) = Factors contributing to inefficiency

z1 = Total Farm size .(hectares)

z2 = Age of the farmers in years,

z3 = Farming experience (years)

z4 = Education level (Years of schooling by farmer)

z5 = Household size (No of persons)

z6 = Non Farm income (N)

z7 = Gender {Dummy1 for male 0 otherwise}

z8 = Extension contact(No, of visits to a farmer by extension worker)

RESULTS AND DISCUSSION.

Socio Economic Characteristics of Cereal Legume Farmers

Age Distribution of Farmers: The analysis of sample farmers in the study area revealed that the age bracket of farmers ranged between 25 and 75 years. Majority of the farmers were between the age limit of 46 – 55 years (36.7%). The most active age group between the ages of 25–35 years is relatively low (15.33%). This is due to the fact that most of the farmers within this age bracket are still in the school or have preference for white collar jobs in the cities. The older age group is the lowest (6.33%) and the average age of the farmers in the study was 48.37. This is presented Table 3.1.

Sex Distribution of Farmers: Gender influences the knowledge, perceptions and needs of the farmers as well as their access to Agricultural technologies, information

and productive resources. Almost all the respondents in Kachia local government area were males 93.3% with only five farmers representing 6.67% were females. In Kagarko Local Government area 86.67% of the respondents were males with only 13.33% females .Women in the area were more limited than men in their access to critical farm resources such as farm land, credit and improved inputs due to cultural, tradition and sociological factors as observed (Tanko, 1994). This implies that most of the sampled farmers in the study area are men and that women interest and involvement in farm decisions making was limited even though women were actively participated in the production process. This result agreed with findings of Rahman (2008) that accessibility rate of women to productive resources was very low in northern Nigeria.

Household Size of the Farmers: A family size or household size is the total number of individuals or people who lived within and feed in the same pot in the household. A household is made up of the head, wives, children and extended family members as defined by (Ogungbile *et al.,* 2002). The study revealed that the household size of the respondent ranged from 2 – 45 number persons. The modal household size was 6 – 10, (44%) in Kachia and (46.66%) in Kagarko local government areas respectively . This is in line with findings of Ogungbile *et al., (2002)* on the family size in Northern Nigeria which shown that most of the household size were within the ranges of 6 to 10 persons. The average household size in the study area was found to be ten persons per household.

Household size is an important socio-economic characteristic in agricultural production in Nigeria. The level of mechanization is very low in the area; hence farmers depend on human labour in carry out farm activities. The size of household determines the size of farm holding and consequently the output from production. From the findings it shows that most (86%) of the household size in the study area are in the range (6 > 15 people). This implied that greater proportion of labour for cereal-legume mixtures could come from family labour and the labour is readily available for timely operations in the farm activities.

Educational Qualification of Farmers

The study revealed that most of the farmers in the study area have only primary school qualification with Kachia having (33.33%) and Kagarko local government having (40%). Those that have adult education qualification were (26.67%) in Kachia and (29.33) in Kagarko local government areas respectively.

Those with secondary school education were (18.66%) in both local government areas. Kachia local government area has more farmers with post secondary school qualification (21.33%) than Kagarko with only (12%) post secondary school qualification as presented in the Table 1.

The analysis revealed that the average farmer in the study area was moderately educated. The implication is that they were better able to take decision as regards to perceptions, adoption and acceptance of innovations.

Farming Experience of Farmers

Farming experience is the number of years over which the farmers has been engaged in

farming. Length of time in farming business can be linked with age. The study revealed that farmers experience in cereal-legume mixtures production ranges from 5 – 46 years. Kagarkohave more sample farmers with more than 20 years experience in cereal legume mixture production (34.67) compared tokachia local government with only (26.67%). The distribution of farmers experience is presented in table 1.

The analysis revealed that about (81.34%) of the farmers in Kagarko local government area have more than ten years experience in cereal- legume production while those in kachia were (54%). This implies that farmers were able to make effective farm management decision on both resource allocation and adhering to best agronomic practices. The average farming experience of 25years in both Local government areas shows that the respondents have sufficient experience in cereal- legume mixture.

Farm Size

Farm size refers to the total land area in hectares that the farmers cultivate. The size of land devoted to any cropping enterprise is a measure of the scale of that enterprise. The farm size of the respondents ranged from one hectare to ten hectares with an average of 2.6 ha. This implies that the production of cereal mixtures in the area is under small scale enterprise. Sampled farmers with farm size greater than 5.5hacteres are more in Kachia Local Government Area (27%) than in Kagarko with only (4%).

It can be deduced that 62% of the respondents had total farm size of less than 4 hectares and only 38% percent have a total farm size of 4 hectares and above. This implies that most of the farmers in study area have small farm holdings and may not practiced mechanize farming.

Characterization of Cereal-legumes in Study Area

Cropping Pattern

Cropping system is one of the important aspects of agronomic practices that affects the efficiency of technology being used in crop production Rahman *et al.* (2002)

The study revealed that the predominant cropping system in the area was mostly Cereal-Legume mixed cropping. Various combinations of cereals and legume were observed in mixture as shown in Table 2.

The most popular cereal legume mixture in the study were maize/soyabeans (30%) followed by Sorghum/groundnut (25%). This is in line with the findings of (Rahman, 2002) that most of the farmers in northern Nigeria grow maize in mixtures with legumes crop such as cowpea, soybeans and groundnut. Others combinations were soya beans/sorghum, maize/groundnut and millet/groundnut. The dominant crops were sorghum, maize, groundnut, soya beans, cowpea and millet. These crops are intercropped in rows in most of the farms with exception of cowpea and millet which are on relay.

Estimate of Input and Output Relationship (Production Frontier Estimate)

The parameters of the model were estimated by maximum likelihood (MLE) using the computer programme frontier 4.1 developed by Coelli (1996). Frontier is a single purpose package specifically designed for estimation of stochastic production frontier and technical efficiency. The maximum likelihood estimate of the stochastic

production for the cereal-legume crop mixtures is presented in Table 3. The (σ) sigma square (7.4345) is statistically different from zero indicating a good fit and the correctness of the specified distribution assumption of the composite error terms. The variance ratio defined as Gamma(γ) was estimated to be 0.1313 implying that technical inefficiency account for about 13.13% of the variation in output levels of cereal-legume crop mixtures.

Production Determinant

The production function indicates the relative importance of the factor inputs used in farming among the cereal-legume crop mixture farms in the study area. Seed and fertilizer were the most important factor influencing the production in the study area. The coefficient of seed (0.37180) is positive and significant at 1% level of probability. Seed is therefore a significant factor associated with changes in output of cereal-legume crop mixtures. The coefficient of fertilizer (0.2877) was also found to be positive and significant at 1% level of probability. Though land, labour, and agro chemicals were positively related to output variations in the study area, estimates from the result shows that their variables were not significant factors influencing output of the cereal-legume crop mixture farms. Mathematically the Cobb-Douglas specification can be expressed as shown below

$lnY = 1.6489 + 1.7159q1 + 0.2035q2 + 0.3718q3 + 0.2877q4 + 0.0664q5$

(0.2570) (0.1671) (0.1568) (0.1198) (0.0892) ((0.0742)

Determinants of Inefficiency

The sources of inefficiency were examined using the estimated (δ) coefficients associated with the inefficiency factors. The factors includes: Farm size, age, farming experience, Education, Household size, Income, Gender and extension contact. According to Udoh (2005), Edet *et-al.,* (2006) estimated coefficients of inefficiency provides some explanations for the relative technical efficiency levels among individual farms. In this study, only age (-0.0117) and household size (-0.2146) were statistically significant at 1% level of probability. That is as the age and household number increases the level of technical efficiencies increases. This may be attributed to the fact that farmers with larger families have more family labour and this is important for timely operation of farming activities which is capable of translating into higher efficiencies. The older farmers because of long years spent in cultivation of cereal legume mixtures might have acquired more experience that could lead to the higher efficiency in production.

Therefore, the inefficiency model can be mathematically expressed as shown below.

$\mu =$ -0.2487 + 0.0083 - 0.0117 - 0.0434 + 0.0036 - 02146+-0.4361+0.0697+0.0036

(0.4646) (0.0105) (0.0012) (0.0011) (0.0066) (0.0002) (0.0002) (0.1737) (0.0008)

As shown in the table 5 the technical efficiencies of the cereal legumes ranged from 0.3095 to 0.9890 with an average technical efficiency of 0.8298. The Table 4 further revealed that only 15 farmers had technical efficiency (T.E) of less than 60%. About 108 farmers representing 72% of the total respondents sampled had efficiency

ranging between 0.80 and 0.99 indicating that more than half of the farmers under cereal legume mixture in the study area were relatively efficient. The average TE of about 0.8298 recorded from the analysis of cereal legume crop mixture in the study area. This implied that the efficiency could be increased by about 18% through better use of available resources. The observed distribution suggest that little production resources are wasted due to inefficient used of resources. With mean efficiency value of about 82% the analysis revealed that production has not reached the frontier threshold.

CONCLUSION

The dominant cereal-legume mixture in the study area are maize/soyabean, sorghum/groundnut maize/groundnut, maize/cowpea and sorghum/soya bean.

The sample farmers are moderately efficient technically given their resources and available technology Seed and fertilizer were the most important factor of production that influences the output of the mixture in the study area.

Two socioeconomic variables (household size and age of the farmers) were inversely and significantly related to the technical inefficiency with the technical efficiency range of 0.6805(0.9890-0.3095) Table5 in the area. Therefore, the null hypothesis was rejected.

RECOMMENDATIONS

The following recommendations are hereby made:

i. The 82.98% level of technical efficiency shows that there is room to improve production to reach the optimum level of 100%. This requires addressing those factors that constraint efficient production by the cereal-legume farmers.

ii. Agricultural societies should be encouraged in the study area in order to cater for the agricultural needs of small scale farmers.

iii. Kaduna state Government should encourage the establishment of Agro processing industries for value change addition of cereal and legume corps in the area.

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Table 3.1 Socio - economics characteristics of respondents

Kachia LGA			**Kagarko LG**	
Age Group **(Years)**	Frequency	Percentage	Frequency	Percentage
25- 35	13	17.4	10	13.33
36-45	18	24.4	19	25.33
46-55	27	36.0	28	37.33
56-65	11	14.6	14	18.67
66-75	6	8.0	4	5.33
Total	75	100	75	100
SEX				
Male	70	93.33	65	86.667
Female	5	6.67	10	13.33
Total	75	100	75	100
House hold size				
1-5	13	17.33	8	10.68
6-10	33	44.00	35	46.66
11-15	13	17.33	28	37.33
>-15	16	21.33	4	5.33

Total	75	100	75	100
Educational Level				
Adult Education	20	26.67	22	29.33
Primary Education	25	33.33	30	40.00
Secondary School	14	18.67	14	18.67
Post Secondary School	16	21.33	9	12.00
Total	75	100	75	100
Farming Experience **(years)**				
1-5	17	22.67	4	5.33
6 – 10	19	25.33	10	13.33
11 – 15	10	13.33	14	18.67
16 – 20	9	12.00	21	28.00
>29	20	26.67	26	34.67
Total	75	100	75	100
Total Farm Size (ha)				
1-2.5	26	34.67	22	29.33
2.6-3.5	15	20.00	30	40.00
3.6-4.5	9	12.00	13	17.33
4.6-5.5	5	6.67	7	9.33
>5.5	20	26.67	3	4.00
Total	75	100	75	100

Source: Field Survey, 2008

Table 2: Major types of cereal-legume mixtures in the study area

Cropping System	No. of Farmers	Percentage
Maize/Cowpea	15	10
Maize/Soyabean/Sorghum	6	4
Millet/Groundnut	5	3.33
Maize/Groundnut	25	16.67
Sorghum,/Soyabeans	20	13.33
Maize/Soyabeans	44	30.16
Sorghum/Groundnut	35	23.33
Total	150	100.00

Source: Field Survey, 2008

Table 3.Estimated cobb-douglas stochastic production function for cereal-legume Mixtures

Input Variables	Parameters	Coefficient	t-ratio
Constant	β_0	1.6489(0.2570) ***	6.4139
Land	β_1	1.7159(0.1671)	0.1026
Labour	β_2	0.2035(0.1568)	1.2978
Seed	β_3	0.3718(0.1198) ***	3.1033
Fertilizer	β_4	0.2877(0.0892) ***	3.226
Agrochemical	β_5	0.0664(0.0742)	0.8949
Inefficiency Model			
Constant	δ_0	-0.2487(0.4646)	-0.5352
Farm Size	δ_1	0.0083(0.0105)	0.7876
Age	δ_2	-0.0117(0.0012) ***	-9.3258
Farming Experience	δ_3	-0.0434(0.0011)	-0.0380
Education	δ_4	0.0036 (0.0066)	0.5499

Household Size	δ_5	-0.2146(0.00002) ***	-9.4094
Non farm income	δ_6	-0.4361(0.0002)	-0.2760
Gender	δ_7	0.0697 (0.1737)	-0.4015
Extension Contact	δ_8	0.0036 (0.0008)	0.4454
Variances			
Sigma Squared	σ	7.434***	7.2255
Gamma	γ	0.1314	0.9104
Log likelihood function	Lf	-9.9728	
	$LRtest$	4.4964	

Source: Field Survey, 2008
*,**,*** level of significance at 10% 5% and 1% respectively
Figures in parenthesis represent standard Error

Table 4: Technical Efficiency of Cereal Legume Mixtures Deciles Range of Frequency Distribution of Technical Efficiency of Farmers Under Cereal Legume Mixture.

Deciles Range Of T.E	Frequency	Percentage
0.3000-0.3999	2	1.33
0.4000-0.4999	4	2.67
0.5000-0.5999	9	6.00
0.6000-0.6999	17	11.33
0.7000-0.7999	10	6.67
0.8000-0.8999	21	14.00
0.9000-0.9999	87	58.00
Maximum Technical efficiency	0.9890	
Minimum Technical efficiency	0.3095	
Mean Efficiency	0.8298	

Source: Field Survey, 2008

Appendix 1 : The indices for conversion into kg-grain-equivalent

Crop	Index
Wheat	1.00
Rice (rough)	0.80
Rice (clean)	1.19
Maize	0.75
Millet	0.68
Sorghum	0.60
Groundnut (shelled)	1.83
Groundnut (unshelled)	1.10
Soybeans	1.30
All pulses	1.12

Source : Clark and Haswell (1970)