ANALYSIS OF TECHNICAL INEFFICIENCY IN FOOD CROP PRODUCTION SYSTEMS AMONG SMALL-SCALE FARMERS IN SOME SELECTED LOCAL GOVERNMENT AREAS OF ADAMAWA STATE, NIGERIA.

By

Maurice, D. C; Joseph, M. and Garba, A.
Department of Agricultural Economics and Extension,
Modibbo Adamawa University of Technology, Yola
e-mail: dmchinda2003@yahoo.com mobile: 08036554382

ABSTRACT

Efficient allocation of resources has been a problem in small holder farm economy in Nigeria. The study examined the technical inefficiency in food crop production systems among small-scale farmers in selected Local Government Areas of Adamawa State, Nigeria. Specifically, the socio-economic characteristics of food crop farmers in the study area were described, the various cropping patterns of the farmers were identified and technical inefficiency of the farmers analysed. Data were collected from 360 randomly selected food crop farmers in eight local government areas spread across the four ADP zones of the State using structured questionnaires. The analytical tools were descriptive statistics involving the use of frequency tables and inferential statistics involving the use of stochastic frontier production function. The result revealed that married female farmers constituted majority (57.22%) of the respondents. Their literacy level was high, as 84% of them had some form of formal education. The respondents cultivated an average of about two hectares of farm land using personal savings. Eleven cropping systems were identified with mixed cropping accounting for about 53% of the cropping systems and about 54% of the total hectarage allocations. The maximum likelihood estimates of the stochastic frontier production function revealed that farm size, family labour, agrochemicals, inorganic fertilizers and seed contributed significantly to food crop output. The technical efficiency (TE) scores ranged from 0.26-0.96 with a mean TE of 0.66, implying that there is a scope for increasing technical efficiency in food crop production by 34% in the short-run under the current technology. Education, extension contact, crop diversification and credit availability were found to decrease technical inefficiency of the farmers. The study recommended farmers education on fundamental farm management skills to enable farmers plan, evaluate and appraise their farm business activities among others.

Kewords: Technical inefficiency, Cropping systems, Small-scale food crop farmers.

INTRODUCTION

The agricultural sector is an important sector in the Nigerian economy in terms of its role in food security, poverty alleviation and economic growth. Food crop production is a major component of all production activities in that sector and comes under different cropping systems, most commonly as mixed farming, mixed cropping or mono cropping due largely to consideration for risk minimization, stable income and adaptability to a particular season (Sani and Haruna, 2010).

Food crop production in Nigeria is dominated by small-scale farmers who cultivate between 0.1 – 5.99 hectares and produce about 85-90% of the total foods consumed in the country (Agbonlahor, 1999; Maurice *et al*., 2013). These farmers are constrained by inadequate finance to expand production, hence rely on personal savings for their agricultural operations. They are also influenced by farm-specific factors, which delineate their production frontiers resulting in low outputs.

When scarce resources are not efficiently utilized by resource poor farmers it could have a multiplier effect on their livelihood and incomes. These farmers would not be able to generate sufficient incomes to mitigate the rising cost of living, increasing population and the normal long dry spell in some parts of the country. This situation creates supply shortages in terms of food availability and accessibility and indirectly creates demand shortages by denying the households access to sufficient income.

The major sources of change in food crop production according to Amaza and Maurice (2005) and Panda (2007) include changes in the hectares of various crops cultivated annually, changing production techniques which affect variation in the yields and the productivity of inputs used in the production of various food crops. Others include; type of technology such as variety and agronomic practices of which cropping system is an important aspect of the agronomic practices. In order to improve resource productivity on farms, farmers need to have proper understanding of how to select enterprises for efficient use of resources.

A number of agricultural development institutions and programmes were set up and special programmes launched by successive governments in the country with the aim of improving food supply situation. Most recently is the Agriculture Transformation Agenda; yet significant volume of food is still being imported annually; while agricultural productivity has not appreciated enough to match domestic demand. The share of food import to total import as a proxy for agricultural contribution to the nation's food supply shows an average annual share of 13%, 9.33% and 9.15% respectively for the periods 1994-1999, 2000-2006 and 2007-2012 (CBN, 2006; 2012).

Productivity growth and resource use efficiency issues are the core elements of sustainable crop production of small-scale farming activities, while inefficient use of production inputs can jeopardize food availability and create scarcity.Thus, the efficiency with which available resources are used by small-scale farmers becomes a priority subject of investigation in view of the growing gap between demand for and supply of food in the country. This therefore, underscores the rationale for inefficiency study among small scale farmersin Adamawa State since food availability is a function of food production and considerable effort has been devoted to the analysis of farm level efficiency in developing countries.

CONCEPTUAL AND EMPIRICAL FRAMEWORK

Efficiency of a farm refers to its performance in the utilization of resources at its disposal (Kalirajan, 2007). This performance is either compared with the normative desired level or with that of any other farm. The analysis of efficiency is generally associated with the possibility of farms producing a certain optimal level of output from a given bundle of resources or certain level of output at least cost.

Farrell (1957) defined technical efficiency as the ability of the firm to produce on the isoquant frontier. It is the ratio of the farm's actual output to its maximum frontier output for a given level of inputs and chosen technology.

Bokusheva and Hockmann (2006) stated that technical efficiency is attained when the best available technology is used. It therefore implies that the frontier output varies with the level of technology employed by the farm. On the other hand, technical inefficiency arises when less than maximum output is obtained from a given bundle of factors (Russell and Young, 1983). Technical efficient farms operate on the production frontier, and the level by which a farm lies below this production frontier is regarded as the measure of technical inefficiency (Asogwa *et al.*, 2011). It results in an equi-proportionate over-utilization of inputs.

Amaza *et al.* (2006) examined the determinants of food crop production and technical efficiency in the northern guinea savanna of Borno State, Nigeria using stochastic frontier production function. A mean technical efficiency index of 0.68 was found, an indication that technical efficiency in food crop production could be increased by 32% through better use of available resources, given the current state of technology. The maximum likelihood estimate (MLE) results revealed that farm size, fertilizer and hired labour were the major factors that were associated with changes in the output of food crops; while farmer specific factors which comprise age, education, credit, extension and crop diversification were found to be the significant factors that account for the observed variation in efficiency among the farmers.

Udoh and Falake (2006) used the stochastic function to estimate output oriented technical inefficiency of crop mix of farmers in Odukpani Local Government area of Cross River State, Nigeria. The result revealed a mean output oriented efficiency of 73%, showing that there exists room for improvement by 27% with the present technology. The existence of technical inefficiency among the farmers accounted for about 27% of the variations in the output levels of the crops grown.

Shehu *et al.* (2007) investigated the productivity and technical efficiency of small-scale rice farmers in North West zone of Adamawa State, Nigeria using stochastic frontier production function. The technical efficiency of the farmers ranged from 0.74 to 0.98, with a mean technical efficiency of 0.96. Farming experience, household size and level of education were found to reduce technical inefficiency.

Oluwatayo *et al.* (2008) examined resource use efficiency of maize farmers in Ekiti State, Nigeria using ordinary least squares regression analysis and stochastic frontier production function. The estimated mean technical efficiency of the farmers is 0.68, indicating that maize farmers in the study area were 68% efficient in the use of production inputs. Amount of hired labour, family labour, pesticides, herbicides and inorganic fertilizer were found to influence technical efficiency level of the farmers.

Jongur *et al.* (2010) determined the farm-level technical efficiency in maize production among farms in Yola North and South Local Government areas of Adamawa State using the stochastic frontier production function. The MLE results revealed that family labour and material inputs (fertilizer and seed) contributed to maize output in the study area. The technical efficiency of maize farmers in the surveyed area ranged from 0.65 to 0.97, with mean technical efficiency of 0.87. This suggests that maize production could be increased by 13% through better use of available resources under the current state of technology.

METHODOLOGY

Adamawa State is located in the North East part of Nigeria between latitude 7.0°N and 11.0°N of the equator and longitude 11.0°E and 14.0°E of the Greenwich meridian (Adebayo, 1999). The State shares common boundary with Taraba State in the South and West, Gombe State in its Northwest and Borno State to the North. It has an international boundary with the Cameroun Republic along its eastern border. The State covers a land mass area of about 38,741km^2 and is divided into 21 Local Government areas. The State has population of 3,161,374 people comprising of 1,580,333 males and 1,581,041 females (NPC, 2006). As opposed to a national annual population growth rate of 3.2%, the population of Adamawa State is growing at 2.8% per annum (Adamawa State, 2006). By 2015, the State is expected to have 4,067,411 inhabitants according to projection.

The State has a tropical climate marked by dry and rainy seasons. The rainy season commences in April and ends in late October. The wettest months are August and September. The mean annual rainfall pattern shows that the amounts range from 700mm in the north-west part to 1600mm in the southern part (Adebayo, 1999). The mean annual rainfall is less than 1000mm in the central and north-western part of the State. On the other hand, the north-eastern strip and the southern part have over 1000mm of rainfall.

The major economic activity of the inhabitants is agriculture (farming, fishing and cattle rearing). Some of the agricultural crops of importance are cereals, roots and legumes supplemented by few planted trees. The main food crops grown are maize, sorghum, millet, rice, cowpea, groundnut, sweet potato, yam and cassava. The farming system employed is either mono-cropping or mixed cropping. Non-farm economic activities include trading, blacksmithing, fishing and animal husbandry among others.

Multi-stage random sampling was employed in the selection of respondents in eight out of the twenty one Local Government Areas of the State. In the first stage, two Local Government Areas were randomly selected in each of the four Agricultural Development Programme (ADP) zones of the State, namely; Mubi North and Madagali Local Governments (Zone I), Gombi and Girei Local Governments (Zone II), Mayo-Belwa and Fufore Local Governments (Zone III), and Guyuk and Ganye Local Governments (Zone IV). Each of the State ADP zone has five LGAs except Zone III that has six. In the second stage three villages were randomly sampled in each of the selected Local Government Areas, giving a total of 24 sampled villages. Third stage sampling involved the random selection of 360 food crop farmers in the 24 sampled villages from the existing sampling frame. Primary data was mainly used for the study and collected through structured questionnaire administration to food crop farmers in the sampled villages with the assistance of trained ADP staff. Data collected were for 2008/2009 and 2009/2010 cropping seasons.

Descriptive statistics involving the use of frequency distributions, percentages and means was used in describing the socio-economic characteristics of the respondents; the stochastic frontier production model was employed to estimate the firm-level technical inefficiency of the farmers in the study area. This model was used because the functional form has been widely used and is still being used in farm efficiency studies in both developing and developed countries. It is given by;

$$TE = Y_i / Y_i^*$$
$$= f(X_i; \beta) \exp(V_i - U_i) / f(X_i; \beta) \exp(V_i)$$
$$TE = \exp(-U_i) \quad .$$

(Equation 1)

Where Y_i^* is the frontier output, Y_i is the observed output, X_i is a vector of input quantities, β is a vector of parameters to be estimated, V_i is the systematic component which represents statistical noise due to factors outside the control of the farmers (e.g weather, measurement errors, disruption of supplies, topography), and is assumed to be independently and identically distributed as $N(0, \delta_v^2)$ and independent of U_i, while U_i is a non-negative one-sided disturbance term used to represent technical inefficiency (or production losses) and is independent of V_i.

$U_i = 0$ for a farm whose output lies on the frontier, and $U_i < 0$ for a farm whose output lies below the frontier. Typically, U_i follows an identical and independent half-normal distribution as $U \sim /N(0,\delta_v^2)/$ and arises from the truncation at zero of the normal distribution.

The empirical model used in determining technical inefficiency of food crop farmers is given by:

$\ln Y_{ij} = \beta_o + \beta_1 \ln X_{1ij} + \beta_2 \ln X_{2ij} + \beta_3 \ln X_{3ij} + \beta_4 \ln X_{4ij} + \beta_5 \ln X_{5ij} + \beta_6 \ln X_{6ij} + V_{ij} - U_{ij}$ (Equation 2)

Where:

Subscript ij refers to the j^{th} observation of the i^{th} farmer.

ln = Logarithm to base e

Y = Output of food crops (kilogram grain equivalent)

X_1 = Total land area under cultivation (ha)

X_2 = Family labour used in production (in mandays) per ha

X_3 = Hired labour used in production (in mandays) per ha

X_4 = Quantity of agro-chemicals (in litres) per ha

X_5 = Quantity of inorganic fertilizer (in kg) per ha

X_6 = Quantity of seeds (in kg) per ha

The technical inefficiency model is defined by:

$\mu_{ij} = \delta_o + \delta_1 Z_{1ij} + \delta_2 Z_{2ij} + \delta_3 Z_{3ij} + \delta_4 Z_{4ij} + \delta_5 Z_{5ij} + \delta_6 Z_{6ij} + \delta_7 Z_{7ij}$. (Equation 3)

Where:

μ_{ij} = The technical inefficiency of the i^{th} farmer

Z_1 = Denotes years of farming experience

Z_2 = Represent years of formal education

Z_3 = Extension contact (number of meetings)

Z_4 = Household size (number)

Z_5 = Primary occupation (dummy, where one indicated farming and zero otherwise)

Z_6 = Crop diversification (dummy, where one indicated sole cropping and zero otherwise)

Z_7 = Credit availability (dummy, where one indicated those that accessed credit and zero otherwise)

The maximum-likelihood estimates of β and δ coefficients were estimated simultaneously using the computer program FRONTIER 4.1, in which the variance parameters are expressed in terms of $\delta^2{}_S = \delta^2 v + \delta^2$ and $\gamma = \delta / \delta^2$ (Coelli, 1994).

RESULTS AND DISCUSSION

The result of the socio-economic characteristics of the respondents as revealed in Table 1 shows that women farmers dominated (57.22%) food crop production in the State thus, agreeing with the findings by Sigot (1995) and Umoh (2006) who reported that women constitute about 60-70% of African agricultural workforce and produce an estimated 70% of total food production. Their age distribution shows that majority (55%) were not more than 40 years of age, while only about 15% were over 50 years of age. Their mean age was 41 years, an indication that they are relatively young and physically active, and this has direct bearing on the availability of able-bodied manpower for primary production.

Majority (about 68%) of food crop farmers in the State have household size of 1-9 persons, with a mean of 8 persons, an indication of relatively large household size. The number of persons in households is very important in determining family labour available for farm-work. Greater family size therefore increases technical efficiency and also eases hiring of labour.

Respondents' educational levels revealed that about 88% of the respondents had some form of formal education. Thus, literacy level is high among the respondents and this could have implication for agricultural production in the area. Education affects productivity through a choice of better inputs and output, and through a better utilization of existing inputs.

This will reduce technical inefficiency in food crop production.

About 78% of the respondents had farming experience of more than 11 years. The mean of farming experience is about 19 years indicating that most of the respondents are well experienced in food crop production. This is expected to translate into significant level of specialization and expertise in food crop production as it could stimulate willingness in the respondents to adopt measures that could improve productivity and overall efficiency in food crop production.

The distribution of farm sizes of the respondents shows that majority (about 65%) of them cultivated up to 2 hectares of farm land, while only about 6% cultivated 6 hectares and above. The mean farm size is about 2 hectares indicating that food crop production in the State is undertaken on a small scale. The farmers are expected to be technically efficient in food crop production owing to their relative small farm sizes.

Table 1: Socio-economic Characteristics of Food Crop Farmers in Some Selected Local Government Areas of Adamawa State

Variable	Frequency	Percentage (%)
Sex		
Male	154	42.78
Female	206	57.22
Age Interval (years)		
≤ 30	62	17.22
31-40	136	37.78
41-50	109	30.28
51-60	42	11.67
>60	11	3.05
Mean	40.99 years	
Household size		
1-4	59	16.38
5-9	186	51.67
10-14	86	23.89
>14	29	8.06
Mean	8.35	
Educational level		
No formal education	43	11.94
Primary education	48	13.33
Secondary education	166	46.11
Tertiary education	103	28.61
Farming experience (years)		
1-5	14	3.89
6-10	66	18.33
11-15	86	23.89
16-20	72	20.0
>20	122	33.89

Mean	18.58 years	
Farm size (ha)		
≤ 2.0	234	65.00
2.1-3.9	65	18.06
4.0-5.9	38	10.56
≥ 6.0	23	6.38
Mean	2.12 ha	

Source: Field survey 2009 and 2010

CROPPING SYSTEMS OF THE RESPONDENTS

Cropping systems are the yearly sequence and spatial arrangement of crops on a given area. The objective of any cropping system is efficient allocation of all resources (Panda, 2007). The distribution of the cropping systems of food crop farmers as presented in Table 2 has revealed eleven (11) cropping systems. Sole cropping accounted for 46.67% of the cropping systems and 45.89% of the total hectarage allocation, while mixed cropping system accounted for 53.33% of the cropping systems and 54.11% of the total hectarage allocation. Maize-based enterprise accounted for 48.07% of the cropping systems and 55.3% of the total hectarage allocation, and is attributed to maize being the staple food of most households in the State. The farm size of all the enterprises ranged from 1.09-3.45ha, an indication that food crop production in the area is undertaken on a small scale. The total hectarage allocation to food crop production among the respondents was estimated to be 762.25ha., with an average farm size of 2.12ha.

Table 2: Distribution of Respondents by Cropping Systems and their Hectarage Allocations

Cropping systems	No. of respondents	%	Total area (ha)	%	Average farm size (ha)
Sole maize	52	12.85	127.50	16.73	1.88
Sole cowpea	34	8.40	54.0	7.08	1.59
Sole rice	61	15.06	118.0	15.48	1.93
Sole groundnut	40	9.88	50.0	6.60	1.09
Maize/cowpea	83	20.49	135.25	17.74	1.63
Maize/sorghum	39	9.63	85.25	11.18	2.19
Maize/sorghum/cowpea	30	7.41	63.0	8.27	2.10
Maize/millet/cowpea	10	2.47	10.50	1.38	1.05

Sorghum/cowpea	32	7.90	67.0	8.79	2.09
Millet/ cowpea	06	1.48	11.50	1.514	1.92
Rice/maize	18	4.44	40.25	5.28	2.24
Total	405*	100.0	762.25	100.0	

Source: Field Survey, 2009, 2010

*Multiple responses

TECHNICAL INEFFICIENCY ESTIMATION IN FOOD CROP PRODUCTION

The maximum likelihood estimates of the stochastic frontier production function for food crop farmers in the study area are presented in Table 3. The estimated coefficients (elasticities) of all the parameters of production function are positive indicating that total food crop output increases by the value of each coefficient as the quantity of each variable input increases by one percent. All the inputs included in the model except hired labour were statistically significant. The return to scale which is the sum of elasticities is 1.87 indicating increasing returns to scale. This shows that the farmers were operating in Stage I of the production surface. This is a situation where by an additional unit of input results in a larger increase in production than the preceding unit. In this case, optimum efficiency of production or resource use has not been attained and resources are either misallocated or under-utilized below the point of economic efficiency.

The sigma squared (0.795) is statistically different from zero at 1% level. This indicates a good fit and the correctness of the specified distributional assumption of the composite error term. Also, the variance ratio defined by Gamma (γ), was estimated at 0.62 suggesting that systematic influences that are unexplained by the production function were the dominant sources of random errors. In other words, the existence of technical inefficiency among the farmers accounted for 62% of the variations in the output levels of the crops grown. This confirms that in the specified model, there is the presence of one-sided error component. It also implies that the effect of technical inefficiency is significant and that a classical regression model of production function based on ordinary least squares estimation would be an inadequate representation of the data. Thus, the diagnostic statistics confirm the relevance of the stochastic production function.

As revealed in Table 3, farm size is the most important factor of production having an elasticity coefficient of 0.547, indicating that the output in food crop production is inelastic to changes in the level of cultivated land area. A 1% increase in hectares of land used in production in the study area *ceteris paribus,* will increase food crop output by 0.547%. This suggests that land is a significant factor associated with changes in crop output and agreeing with the findings by Amaza *et al.* (2006) that farm size is a major factor associated with changes in the output of food crops

Inorganic fertilizer is the second most important factor, with an elasticity coefficient of 0.47 and statistically significant at 1%. Fertilizer is a major input which improves the productivity of existing land by increasing crop yields per hectare. A 1% increase in the use of inorganic fertilizers in the study area will increase output of food crop by 0.47%. Maize, rice and other cereals require a lot of nitrogen for maximum yield and this is supplied by the inorganic fertilizers. Moreover, the fertility status of most soils in the study area may be poor due to continuous cropping hence, necessitating augmentation through the use of inorganic fertilizers.

Seed input has an elasticity coefficient of 0.347 and positively related to total output of food crop in the study area. This shows that a 1% increase in quantity of seeds used in production will increase output of food crop by 0.347%. By implication, raising the productivity of seed is expected to translate into a more than proportionate increase in the output of food crop per hectare. This agrees with Amaza and Olayemi (2002) who stated that agricultural productivity can be increased through increase in the quantity of a particular input, or increase in the productivity of input, or a combination of both.

The significance of family labour to crop mix in the study area cannot be over-emphasized as the coefficient of family labour (0.315) is significant and positively related to food crop output. This means that an increase in mandays of family by 1% in the study area will increase food crop output by 0.315%. The implication is that respondents with larger household size have the potential for higher farm output in that labour needed for the execution of important farm operations such as weeding would be readily available.

Agrochemical which includes both herbicides and pesticides has an elasticity coefficient of 0.037 and statistically significant at 5%. This means that a 1% increase in the quantity of agrochemicals used in crop production will increase output of food crop by 0.037%. The use of herbicides besides reducing the expenditure on weeding reduces the use of manual labour associated with food crop production. It also help farmers that are not constrained by land to increase their scale of production. Pesticides on the other hand increases yield of crops by destroying pests that affect crops. This implies that the use of agrochemicals not only increases the productivity of seed input but also enable farmers to cultivate large hectares of land, which will ultimately increase the food crop output.

The inefficiency parameters are specified as those relating to farmers' specific socio-economic characteristics and were examined by using the estimated δ coefficients. A negative δ coefficient indicates that the parameter has a positive effect on efficiency and vice versa.

Education increases one's ability to receive, decode and understand information relevant in making production decisions. The coefficient of education variable was estimated to be negative and statistically significant at 1% level implying that inefficiency in food crop production among the farmers' decreases with education. Educated farmers are more likely to be more efficient in food crop production than the uneducated ones due to enhanced ability to acquire technical knowledge on the use of improved technology, such as the application of fertilizers, use of pesticides and so on, and this makes them move closer to the frontier output. This finding agrees with comparable findings by Amaza *et al.* (2006), Fasasi (2007), Shehu *et al.* (2007), Tanko and Jirgi (2008) who also found a positive relationship between education and technical efficiency.

Agricultural extension enhances the efficiency of making adoption decisions. The coefficient of the extension contact was estimated to be negative and statistically significant at 5% level. This indicates that increased extension services to farmers tend to decrease technical inefficiency in food crop production. Extension visits affords the farmer the opportunity to learn improved technologies and how to acquire the needed inputs and services. The significance of extension in this study corroborates the findings of Paudel and

Matsuoka (2009) and Jongur *et al.* (2010) who reported positive influence of extension contact on efficiency.

The crop diversification variable in the model is negative and statistically significant at 5% level. This implies that as diversification decreases and fewer crops are grown, technical inefficiency increases. Thus, crop diversification is associated with higher relative efficiency. The cost of farm operations under mixed cropping is expected not to significantly vary from those under sole cropping, but total yield obtained under mixed cropping is expected to be higher with efficient allocation of resources due to multiplicity of enterprises. The coefficient of credit availability variable is negative and statistically significant at 1% level. This suggests that farmers who have greater access to credit tend to be more efficient in food crop production. Also, the availability of credit helps to finance the purchasing of inputs, especially fertilizer, which has positive effect on the productivity of farmers.

Table 3: Maximum Likelihood Estimates of the Parameters of the Stochastic Frontier Production Function

Variable	Parameter	Coefficient	t-ratio
Production factors			
Constant	β_0	2.747	3.1510*
Farm size (X_1)	β_1	0.547	3.4908*
Family labour (X_2)	β_2	0.315	2.0622**
Hired labour (X_3)	β_3	0.150	1.5634
Agrochemicals (X_4)	β_4	0.037	2.1313**
Inorganic fertilizer(X_5)	β_5	0.470	3.9577*
Seed(X_6)	β_6	0.347	3.5621*
Inefficiency effects			
Constant	δ_0	-0.026	-0.0274
Farming experience (Z_1)	δ_1	-0.462	-1.4241
Education (Z_2)	δ_2	-0.061	-3.9257*
Extension contact (Z_3)	δ_3	-0.473	-2.6414**
Household size (Z_4)	δ_4	-0.026	-0.0298
Primary occupation (Z_5)	δ_5	-0.021	-0.0217
Crop diversification ($_6$)	δ_6	-0.664	-2.2426**
Credit availability (Z_7)	δ_7	-1.132	-10.5308*
Diagnostic statistics			
Likelihood ratio		3.343	
Sigma-squared	(σ^2)	0.795	2.8429*
Gamma	(γ)	0.624	3.3727*

Source: Computer output from Frontier 4.1, * Significant at 1% level; **Significant at 5% level

The distribution of farmers' technical efficiency indices derived from the analysis of the stochastic production function is presented in Table 4. The technical efficiency indices of the sampled farmers were less than 1.00, indicating that food crop farmers in the study area were producing below the maximum efficiency frontier. A range of technical efficiency indices were observed across the sample farms and the spread is large. The best farm had a technical efficiency of 0.96 (96%), while the worst farm had a technical efficiency of 0.26 (26%). The mean technical efficiency was 0.66 (66%) implying that, on the average, the respondents were able to obtain a little over 66 percent of optimal output from a given mix of production inputs. This indicates that in the short run, there is a scope for increasing technical efficiency in food crop production in the study area by 34 percent. The distribution of technical efficiency scores of the farmers revealed that about 18% had technical efficiency of less than 50 percent, while about 51% had technical efficiency of 50-69 percent. Only about 31% of the respondents had technical efficiency scores of 70% and above. This result is similar to the ones obtained by Amaza *et al.* (2006) in Gombe State and Oluwatayo *et al.* (2008) in Ekiti State who both obtained a mean technical efficiency of 0.68.

Table 4: Technical Efficiency Pattern of Food Crop Farmers

Efficiency level	**Frequency**	**Percentage**
0.20 – 0.29	3	0.83
0.30 – 0.39	9	2.50
0.40 – 0.49	53	14.72
0.50 – 0.59	73	20.28
0.60 – 0.69	110	30.56
0.70 – 0.79	64	17.78
0.80 – 0.89	40	11.11
0.90 – 1.00	8	2.22
Total	360	100
Mean 0.66		
Minimum 0.26		
Maximum 0.96		

Source: Field Survey, 2009

CONCLUSION

Food crop production in Adamawa State is mostly undertaken by the female genders that are mostly full-time farmers and well experienced in food crop production. They cultivated an average farm size of about 2 hectares and utilized personal savings in agricultural production, an indication that agricultural production is still at subsistence level.

Mixed cropping dominated the cropping systems where maize-based enterprise accounted for 48% of the cropping systems and about 55% of the total hectarage allocation to food crop production. The food crop production in Adamawa State operate at a mean technical efficiency of 0.66, indicating that there is a scope for increasing food crop output in the short-run by 34% through efficient utilization of existing inputs given the current state of technology. Farm size, inorganic fertilizers, seed, family labour and agrochemicals contributed significantly to food crop output; while socio-economic variables such as extension contact, education, crop diversification and credit availability were found to reduce farmers' technical inefficiency in food crop production.

RECOMMENDATIONS

Based on the findings of this research, the following recommendations are proffered.

1. To reduce the negative consequences of inefficient use of resources, farmers should be educated by government and non-governmental agencies on fundamental farm management skills which will enable them to plan, evaluate and appraise their farm business activities. There is also the need for farmers to acquire basic education since education positively influences efficiency.

2. Effective extension programmes that will educate farmers on efficient allocation of production resources are points upon which the various smallholder development programmes initiated by the government should be built. To this end, the extension arm of the ADP should be resuscitated and strengthened through adequate funding by the government instead of introducing new schemes and programmes which duplicates tasks.

3. Government and donor agencies should encourage and support crop breeding researches so as to raise the productivity of existing seeds. Also, the outcome of such researches should get to the farmers instead of remaining in the libraries and archives.

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