DOI:10.26524/jms.2013.60

Technical Efficiency Differential of Groundnut Production in Jigawa State, Nigeria

REKWOT G.Z., DAMISA M.A AND YUSUF O.
Department of Agricultural Economics and Rural Sociology, Faculty of Agriculture, Ahmadu Bello University, Zaria, Nigeria.

ABSTRACT: This study was undertaken to principally determine the technical efficiency differential of groundnut production by adopters and non-adopters of Institute for Agriculture (IAR) groundnut varieties in Jigawa state, Nigeria.Interview schedule was used to collect data from a sample of 227 respondents who were selected randomly from the four agricultural zones in the study area. The analytical tools employed in data analysis include descriptive statistics and stochastic frontier production function. The result of the Maximum Likelihood Estimation of the stochastic frontier production function revealed that the maximum, minimum and mean efficiencies of farmers who adopted IAR groundnut varieties were 91%, 18% and 70% respectively while in the case of farmers who did not adopt, the maximum, minimum and mean efficiencies were 88%, 18% and 63%. This implies that the farmers who adopted IAR groundnut varieties are more technically efficient than farmers who did not adopt IAR groundnut varieties. Therefore, adopting of IAR groundnut varieties by farmers can contribute in enhancing their technical efficiency.The sources of technical inefficiency of adopters of IAR groundnut varieties were age ($P<0.01$), family size ($P<0.01$), education ($P<0.01$), extension ($P<0.01$) and credit ($P<0.05$). The result of the inefficiency model of the non-adopters of IAR groundnut varieties revealed that the major factors influencing the technical inefficiency were family size ($P<0.01$), education ($P<0.01$), farming experience ($P<0.05$) and extension contact ($P<0.05$). Based on the findings of the study, Based on the findings of the study, it is recommended that Government should fast track seed multiplication and distribution through effective extension service delivery to farmers so as to intensify and sustain the adoption of improved groundnut varieties towards enhancing the technical efficiency of groundnut farming households.

Keywords: Adopters, Institute for Agriculture (IAR), Groundnut, Non-adopters, Technical Efficiency.

1. INTRODUCTION

Agriculture is an important sector in the economic development and poverty alleviation drive of many countries. The importance of this sector is more pronounced in the developing countries including Nigeria where it is the main thrust of national survival, employment, food and foreign exchange earnings [1] [2]. In Nigeria, agricultural production is still carried out using physical strength, which declines with age. This has therefore been observed as one of the major constraints to agricultural production in Nigeria [3].

Groundnut is one of the most popular commercial crops in Nigeria. Nigeria produces 41% of the total groundnut production in West Africa [4].During 2000-2009, the groundnut areas grew annually 2.6% in Nigeria but the yield declined by 3.3% annually resulting in stagnation of groundnut production at 2.9 million tonnes [5].The production of groundnut in Nigeria fluctuated over the years from 1,565,000 tonnes in 1961 to 611,000 tonnes in 1985 and subsequently increased to 2,636,230 tonnes in 2010[6]. However, the yield of groundnut decreased remarkably from 16, 492 kg/ha in 1990 to 10, 000 kg/ha in 2010. The production of groundnut in Nigeria has suffered major setbacks from the groundnut rosette epidemics and foliar diseases, aflatoxin contamination and lack of sufficient and consistent supply of improved seed varieties [7]. This has significantly affected productivity and led Nigeria to lose its shares in the domestic, regional and international markets. To regain its competitiveness, groundnut yield would have to increase substantially using yield enhancing varieties. This prompted the development of improved groundnut varieties by IAR namely SAMNUT 1, SAMNUT 2, SAMNUT 3, SAMNUT 5, SAMNUT 6, SAMNUT 9, SAMNUT 10, SAMNUT 11, SAMNUT 16, SAMNUT 18, SAMNUT 19, SAMNUT 20, SAMNUT 21, SAMNUT 22, SAMNUT 23, SAMNUT 24.

Several empirical studies on economic aspect of groundnut production have been conducted in the study area but there exists a research gap in the area of technical efficiency of groundnut production by farmers who are using improved groundnut varieties developed by IAR and those who are using local groundnut varieties in the study. It is on this premise that this study was designed to fill the existing research gap and also contribute to the existing literature on technical efficiency of crop production in Nigeria. Hence, the specific objectives of the study were to:

1. estimate and compare the technical efficiency of the farmers that adopted IAR groundnut varieties and those who did not adopt IAR groundnut varieties in the study area.
2. Determine the sources of technical inefficiency of farmers who adopted IAR groundnut varieties and farmers who did not adopt IAR groundnut varieties in the study area.

2. THEORETICAL FRAMEWORK

2.1 *Farm efficiency and production*

Efficiency is the act of achieving good result with little waste of effort. It is the act of harnessing material and human resources and coordinating these resources to achieve better management goal. [8] distinguished between the types of efficiency (a) Technical Efficiency (TE), (b) Allocative Efficiency (AE) and (c) Economic Efficiency (ER), by saying that farm efficiency can be measured in terms of all these type of efficiency. The appropriate measure of technical efficiency is input saving which gives the maximum rate at which the use of all the inputs can be reduced without reducing output. Technical efficiency is defined as the ability to achieve a higher level of output, given similar levels of inputs. Allocative efficiency deals with the extent to which farmers make efficiency decisions by using inputs up to the level at which their marginal contribution to production value is equal to the factor cost. Economic efficiency is concerned with the realization of maximum output in monetary term with the minimum available resources. Production is defined as the transformation of goods and services into finished products (that is input-output relationship) and this is also applied to every production process, maize production inclusive. [9] define production process as one whereby some goods and services called inputs are transformed into other goods and services called output. In agriculture, the physical inputs which we use are: land, labour, capital and management.

3. METHODOLOGY

3.1 Description of the study area

Jigawa state lies between latitude11^{0}N and 13^{0}N and longitudes 8^{0}E and 10^0 35′E and shares a common border with Kano and Katsina state to the west, Bauchi state to the south-east, Yobe state to the east and Republic of Niger to the north. Its population is put at 4, 361, 002 people in 2006 [10] and a projected population of 5, 058, 762 people in 2011 at a growth rate of 3.2 percent per annum.80% of the population is found in the rural areas and is made up of mostly Hausa, Fulani and Manga (a Kanuri dialect). The climate of the state is characterized by two distinct seasons; the rainy and dry seasons. The rainy season lasts from May to September with average rainfall of between 600 mm to 1000 mm.The climate of the area favours the production of crops such as maize, beans, groundnut, guinea corn, millet, cotton, yam, carrot, sugarcane, tomatoes, pepper, onions garden eggplant, lettuce, amaranthus and tobacco.

3.2 Sampling procedure and Sample Size

Multi-stage sampling technique was employed in selecting the groundnut farming households for this study. The first stage was a purposive selection of four Local Government Areas from the study area (one Local Government from each of the four ADP zones in the state). These Local Government Areas were selected on the basis of being the most prominent groundnut producing areas of the state. Secondly, eight villages were purposively selected (two villages from each of the four selected local government areas) on the basis of their high intensity of groundnut production activities. Thirdly, simple random sampling was employed in selecting 10 % of the groundnut farming households to give a sample size of 227

3.3 Method of Data collection

The study made use of primary data. Primary data were obtained through the use of well-structured questionnaire to be administered to household heads using well trained enumerators. The data collected during the field survey were on socio-economic characteristics such as age, gender, marital status, household size, farm size, income, access to credit, number of extension contacts, level of education of household heads and the household size. Also, data on input and output of groundnut production were also collected.

3.4 Analytical Technique

Stochastic production frontier was employed using the variant of the stochastic production function analysis adopted by [11]. The stochastic frontier production model has the advantage of allowing simultaneous estimation of individual technical and allocative efficiencies of the farmers as well as the determinants of technical efficiency [11]. Economic application of stochastic frontier model for efficiency analysis include [12] in which the model was applied to U.S agricultural data,[13] [14] [15] in which they offer comprehensive review of the application of the stochastic frontier model in measuring the technical and economic efficiencies of agricultural producers in developing countries.

It is assumed that the farm frontier production function can be written as:

$$Y_i = f(X_i; \ ) + e_i \quad \ldots\ldots 1$$

Where:

Y_i = quantity of agricultural output in specified unit
X_i = is the vector of input quantities
□ = is the vector of production function or unknown parameters to be estimated
(X_i;□) is a suitable functional form such as Cobb-Douglas
The production function f (X_i;□) is a measure of maximum potential output for any particular Input Vector
X_i=vector of the inputs used by the farm
□ = is the vector of parameters to be estimated
e_i= is the error term and is the farm specific composite residual term comprising of a random error term V_i and an inefficiency component U_i.
The Cobb-Douglas stochastic production function is stated as follows:

$$\text{In } Y = \square_0 + \square_1 \text{ In } X_1 + \square_2 \text{ In } X_2 + \square_3 \text{ In } X_3 + \square_4 X_4 + \square_5 \text{ In } X_5 + V_{it} - U_{it} \quad \ldots\ldots 2$$

Where:

Y = total farm output of groundnut (Kg)
X_1 = cultivated farm area for groundnut (ha)
X_2 = quantity of seeds planted (kg)
X_3= quantity of agrochemicals (litres)
X_4 = quantity of labour (man days)
X_5 = quantity of fertilizer used (kg)

□ = Vector of the coefficients for the associated independent variables in the production function
U_{it} = one sided component, which captures deviation from frontier as a result of inefficiency of the firm
V_{it}= effect of random stocks outside the firm control, observation and measurement error and other stochastic (noise) error term.
In = the natural logarithim (to base e)
The technical inefficiency effects U_i is specified as follows:

U_i = □ $_0$ + □ $_1Z_1$ + □ $_2Z_2$ + □ $_3Z_3$ +□ $_4Z_4$ + □ $_6Z_6$............ 3
Z_1 = age of the farmers (years)
Z_2 = Family size (number of members of the family)
Z_3 = education of the farmer (years of formal schooling)
Z_4 = farming experience (years)
Z_5 = number of contacts with extension agents per cropping season (number of contacts)
Z_6 = amount of credit obtained (naira)
Z_1-Z_6 = are the scalar parameters to be estimated.

4.0 RESULTTS AND DISCUSSION

4.1 Technical efficiency of Adopters and Non-Adopters of IAR groundnut varieties

The MLE estimates of the parameters of the stochastic frontier production function as presented in Tables 1 and 2 shows that the estimated sigma squared for the adopters of IAR groundnut varieties (2.3349) and non-adopters of IAR groundnut varieties (2.1603) were significantly different from zero at 1% probability level. This indicates a good fit and the correctness of the specified distributional assumption of the composite error terms in the estimated models for the adopters and non-adopters. The value of gamma for the adopters (0.9266) and the non-adopters (0.8594) were significant at 1% suggesting that 93% and 86% of the shortfall below the frontier output of the adopters and non-adopters respectively was due to the inefficiencies of the farmers.

The estimated coefficient of land for adopters (7.3824) and non- adopters (0.8371) were positive and significant at 1% probability level respectively indicating that a unit increase in farm size of the farmers will lead to an increase in their output by a magnitude of 7.3824 and 0.8371 respectively *ceteris paribus*. This result is in line with [16] who reported that farm size was significant and had a positive relationship with the output level of farmers in a study on the efficiency of participation of youth in agriculture programme in Ondo State, Nigeria. The coefficient of seed for the adopters was positive and significant at 10% probability level indicating that a unit increase in seed will lead to an increase in output by a magnitude of 0.1157. This result agrees with that of [17] who reported a positive relationship between seed and output of rice farmers in a study on technical efficiency differentials in rice production technologies in Nigeria. While for the non-adopters, the coefficient of seed was negative and not significant. The estimated coefficient of labour for adopters and non-adopters was positive and significant at 1% and 5% probability levels respectively in line with *a priori* expectation indicating that a unit increase in labour use will bring about an increase in the output of the adopters and non-adopters. This finding disagrees with [18] who found that labour had a negative influence on the output of rural farmers in a study on technical and allocative efficiency analysis of Nigerian rural farmers. The estimated coefficient of fertilizer for the adopters was negative and significant at 5% probability level implying that a unit increase in the use of fertilizer will decrease output by a magnitude of 0.2640 while in the case of the non-adopters, it was not significant.

The result of the determinants of the technical inefficiency of the adopters and the non-adopters of IAR groundnut varieties are presented in Tables 1 and 2 respectively. Since the dependent variable of the inefficiency model represents the mode of inefficiency, a positive sign of an estimated parameter implies that the associated variable has a negative effect on efficiency but positive effect on inefficiency and vice versa [19]. The estimated age coefficient was positive with respect to various production inefficiencies of the adopters and non-adopters. This coefficient was statistically significant at 1% for the adopters. This implies that age contributed positively to their technical inefficiency and hence, as the farmers grow older, their technical efficiency decreases. The coefficient of age was not significant for the non-adopters. Family size was negative and significantly related to the technical inefficiency of the adopters as well as the non-adopters at 1% and 5% respectively. This finding is in line with that of [20] who reported that family size was negative and significantly related to the technical inefficiency of rice farmers in Taraba Stat e, Nigeria.Education was negative and significantly related with the technical inefficiency of adopters and non-adopters at 1% probability level which implies that as the educational status of the farmers increases their technical inefficiency decreases thereby increasing their technical efficiency. Educated farmers are able to gather, understand and use information from research and extension more easily than illiterate farmers can. Moreover, educated farmers are very likely to be less risk-averse and therefore more willing to try out modern technologies. This result agrees with [21] who reported that education was negative and significantly related to the technical, allocative and economic efficiencies of Tomato Farms in Northern Pakistan. The coefficient of farming experience was significant at 1% and 5% probability levels respectively and positively related with the technical inefficiency of adopters and non-adopters. This finding is not in line with that of [17] who also reported that farming experience was negative and significant in their studies.The coefficient of extension contact had the expected negative sign and was significantly related with the technical inefficiency of adopters at 1% probability levels respectively. This implies that as the number of extension contacts of the adopters increases, their technical inefficiency decreases thereby increasing their technical efficiency. This result is in consonance with the finding of [18] who obtained similar result in their study. The coefficient of extension contact for the non-adopters had a positive sign and was significant at 5%. A similar finding was reported by other studies which found a positive relationship between farm level efficiency and availability of extension services [22] [23] [24] [14].The coefficient of access to credit for adopters was negative and significant at 10%. This implies that the higher the access to credit, the more efficient the farmers became. This is in disagreement with [25], who showed that receiving credit contributed to farmers‘ economic inefficiency. If production credit is invested on the farm, it is expected that this will lead to higher levels of output. Thus, access to credit is more likely to lead to an improvement in the level of technical efficiency of the adopters of IAR groundnut varieties. In the case of non-adopters of IAR groundnut varieties, access to credit was not significant.

Table 1.0: Maximum Likelihood Estimates of the parameters of Stochastic Frontier Production Function of farmers who adopted IAR groundnut varieties

Variables	Coefficient	Standard-error	T-ratio
General model			
Intercept	7.8446*	0.6550	11.9814
Cultivated farm area	7.3824*	0.0871	8.4750
Seed	0.1157***	0.0599	1.9333
Agro-Chemicals	-0.0382	0.0452	0.8460
Labour	0.0962*	0.0342	2.8093
Fertilizer	-0.2640**	0.1102	-2.3900
Inefficiency model			
Intercept	-5.4544	2.1863	-2.4948
Age	0.1126*	0.0434	2.5946
Family size	-0.4466*	0.1306	-3.4192
Education	-0.1947*	0.0693	-2.8075
Farming experience	0.1167*	0.0465	2.5115
Extension	0.2558*	0.0951	2.6910
Credit	-0.0003**	0.0001	-2.3263
Variance parameters			
Gamma	0.9266*	0.0333	27.8451
Sigma	2.3349*	0.5639	4.1406
Log likelihood Function	-93.5619		
LR test	85.5973		

NB: Values in parentheses are the standard errors, * P < 0.01, ** P < 0.05, *** P < 0.1

Table 2.0: Maximum Likelihood Estimates of the parameters of Stochastic Frontier Production Function of farmers who did not adopt improved groundnut varieties

Variables	Coefficient	Standard-error	T-ratio
General model			
Intercept	7.9677*	0.9665	8.2442
Cultivated farm area	0.8371*	0.1271	6.5881
Seed	-0.0597	0.0726	-0.8228
Agro-Chemicals	-0.0669	0.0519	1.2894
Labour	0.1058**	0.0437	2.4167
Fertilizer	-0.1923	0.1548	-1.2420
Inefficiency model			
Intercept	-2.2967	1.9757	-1.1625
Age	0.0425	0.0593	0.7172
Family size	-0.3901*	0.1303	-2.9938
Education	-0.2440*	0.0877	-2.7805
Farming experience	0.1332**	0.0539	2.4711
Extension	0.2904**	0.1306	2.2235
Credit	-0.0002	0.0002	-1.4632
Variance parameters			
Gamma	0.8594*	0.0671	12.7998
Sigma	2.1603*	0.6942	3.1118
Log likelihood Function	-119.6118		
LR test	68.4151		

NB: Values in parentheses are the standard errors, * P < 0.01, ** P < 0.05, *** P < 0.1

4.2 Frequency distribution of the technical efficiency of Adopters and non-adopters of IAR groundnut varieties

The technical efficiency distribution of adopters and non-adopters as presented in Table 3.0 shows that 62.7% of the adopters of IAR groundnut varieties operated above 69% efficiency level compared to the non-adopters with 59.1% found to have operated above 69% efficiency level. Also, the most efficient farmer who adopted IAR groundnut varieties operated at 91% efficiency level and the least efficient adopter operated at 19% efficiency level with mean efficiency of 70% while in the case of the farmers who did not adopt, the most efficient farmer operated at 88% and the least efficient farmer operated at 18% with mean efficiency of 63%. This result clearly shows that farmers who adopted IAR groundnut varieties were more technically efficient than farmers who did not adopt. Although, the farmers who adopted these varieties were more technically efficient than the farmers who did not adopt, there is still opportunity for them to increase their efficiency by 30% through better use of available production resources given the level of technology. Alsothe non-adopters still have room to increase their efficiency of production by a range of 31% through efficient resource utilization given the current level of available resources.

Table 3.0: Frequency distribution of the technical efficiency of adopters and non-adopters of IAR groundnut varieties

	Adopters		Non-Adopters	
Efficiency	Frequency	Percentage	Frequency	Percentage
0.10 – 0.19	1	0.9	1	0.9
0.20 – 0.29	1	0.9	1	0.9
0.30 – 0.39	3	2.7	1	0.9

0.40 – 0.49	9	8.2	8	6.8
0.50 – 0.59	5	4.6	5	4.0
0.60 – 0.69	22	20.032		27.4
0.70 – 0.79	39	35.5	4	39.3
0.80 – 0.89	30	27.2	23	19.7
0.90 – 0.99	2	1.8	-	0.0
Total	110	100.0	117	100.0
Minimum efficiency (%)	19		18	
Maximum efficiency (%)	91		88	
Mean efficiency (%)	70		63	

NB: the symbol (-) implies not applicable

5.0 CONCLUSION AND RECOMMENDATION

The empirical findings of the study revealed that the maximum, minimum and mean efficiencies of farmers who adopted IAR groundnut varieties were 91%, 18% and 70% respectively while in the case of farmers who did not adopt, the maximum, minimum and mean efficiencies were 88%, 18% and 63%. This suggests that adopters of IAR groundnut varieties were more efficient than farmers who are using local varieties and therefore, adoption of IAR groundnut varieties by farmers can be used as a veritable tool for contributing in enhancing the technical efficiency of groundnut farmers in the study area. hesources of technical inefficiency of adopters of IAR groundnut varieties were statistically significant at 5 and 1% significance levels. The result of the inefficiency model revealed that the sources of technical inefficiency of adopters of IAR groundnut varieties were age ($P<0.01$), family size ($P< 0.01$), education ($P<0.01$), extension ($P<0.01$) and credit ($P<0.05$). The result of the inefficiency model of the non-adopters of IAR groundnut varieties revealed that the major factors influencing the technical inefficiency were family size ($P<0.01$), education ($P<0.01$), farming experience ($P<0.05$) and extension contact ($P<0.05$). In line with the findings of the study, it is recommended that Government should fast track seed multiplication and distribution through effective extension service delivery to farmers so as to intensify and sustain the adoption of improved groundnut varieties towards enhancing the technical efficiency of groundnut farming households. This study also recommends that farmers education should be enhanced especially through extension education. This is because farmers education can aid in reducing the productive inefficiencies among groundnut farming households.

6.0 REFERENCES

[1] Abdullahi, Y. A. (1986). *Economic Growth and Social Equity in Developing Countries,*California, Stanford University Press. 53 – 65.

[2] Adebayo, K. and Okuneye, P. A. (2005). Economics of Agricultural Extension In: *Agricultural Extension in Nigeria*Adedoyin, S. F. (ed) 251 pp.

[3] Okeowo, T.A.; Agunbiade, J.B. and Odeyemi, L.A. (1999). An Assessment of the Level of Involvement of Farm-Children in Farming Decisions in IkoroduArea of Lagos State. In *Farm Children and Agricultural Productivity in the 21st Century*Proceedings of the Second Annual Conference of Children-In- Agricultural Programme (CIAP) held at the Conference Centre, O.A.U., Ile-Ife (eds Stella, B.W.; Oginni, F.O. and Akinloye, J.F.). May. Pp. 275 – 282.

[4] Echekwu, C.A and Emeka, I. (2005). Groundnut, endowing, the groundnut rediscovery programme in Nigeria.Opahmission Abuja pp 18

[5] International Crops Research Institute for Semi-Arid Tropics(ICRISAT), (2011). Briefing on Mandate Crops. Available at: http://www.icrisat.org/crop-groundnut.htm. Accessed online 20th January, 2013.

[6] Food and Agriculture Organization(FAO), (2012).FAOSTAT database. http://faostat.fao.org. Accessed 1st July 2012.

[7] Bashir, B. (2012). Groundnut Pyramids: Lost pride of the North. Retrieved 25 October, 2012 from http://www.freedomradionig.com/index.php/component/content/article/39-icetheme/editorials/159-groundnut-pyramids-lost-pride-of-the-north.

[8] Farrell, J. M. (1957). The measurement of productive and efficiency.*Journal of Royal statistics Society*. 120: 253–290.

[9] Olayide, S.O. and Heady, E.O. (1982). *Introduction to agricultural production economics*. University of Ibadan Press, Nigeria

[10] National Population Commission(NPC), (2006). Official Census Figures.NPC, Abuja, Nigeria.

[11] Battese, G. E. and Coelli, T. J. (1995). A model for technical inefficiency effect in a stochastic Frontier production function for panel data.*Empirical Economics,* 20: 325-332.

[12] Aigner, D. J., Lovell, C. A. K. and Schimidt, P. (1977). ―Formulation and Estimation of Stochastic Frontier Function Models‖, *Journal of Econometrics*,6: 21– 37.

[13] Ogundari, K and S.O. Ojo (2006), **"**An Examination of Technical, Economic and Allocative Efficiency of Small Farms: The Case Study of Cassava Farmers in Osun State of Nigeria‖ *journal of Central. European Agriculture***,** 7(3): 423-432.

[14] Bravo-Ureta, B. E. and R.E. Evenson (1994). Efficiency in Agricultural Production: The Case of Peasant Farmers in Eastern Paraguay. *Agricultural Economist*, 10 (1): 27-37.

[15] Ali, M. and Byerlee, D. (1991). Economic efficiency of small scale farmers in a changing world.A survey of recent evidence.*Journal of Development Studies*.4: 1-27.

[16] Muhammad-Lawal, A., Omotesho, O.A. and Falola, A. (2009).Technical efficiency of youth participation in agriculture: a case study of the youth - in - agriculture programme in ondo state, south western Nigeria. *Nigerian Journal of Agriculture, Food andEnvironment,* 5(1):20-26.

[17] Okoruwa, V. O. and O. O. Ogundele (2004). Technical Efficiency Differntials in Rice Production Technologies in Nigeria. www.csae.ox.ac.uk/conference/2006-EO RPI/papers/csae/okoruwa.pdf.

[18] Asogwa, B.C., Umeh, J.C. and Penda, S.T. (2011). Analysis of Economic Efficiency of Nigerian Small Scale Farmers: A Parametric Frontier Approach. *Journal of Economics*, 2(2): 89-98.

[19] Rahji, M.A.Y. (2005). Determinants of Efficiency Differentials in Lowland Rice Production Systems in Niger State, Nigeria.*Ibadan Journal of Agricultural Research*, 1(1):7 – 17.
[20] Ahmadu, J. and Erhabor, P. O. (2012). Determinants of Technical Efficiency of Rice Farmers in Taraba State, Nigeria.*Nigerian Journal of Agriculture, Food and Environment*, 8(3):78-84.
[21] Himayatullah, K. and Imranullah, S. (2011). Measurement of Technical, Allocative and Economic Efficiency of Tomato Farms in Northern Pakistan. International Conference on Management, Economics and Social Sciences.459-468
[22] Kalirajan, K. (1981). An Econometric Analysis of Yield Variability in Paddy Production.*Canadian Journal of Agricultural Economics*, 29 (3), pp. 283–94.
[22] Kalirajan, K., and J. C. Flinn (1983). The Measurement of Farm-Specific Technical Efficiency.*Pakistan Journal of Applied Economics*, 2 (2), pp. 167–80.
[23] Kalirajan, K., and R. T. Shand (1985). Types of Education and Agricultural Productivity: A Quantitative Analysis of Tamil Nadu Rice Farming. *Journal of Development Studies*, 21 (2), pp. 232–43.
[24] Okike, I., M.A. Jabbor, V., K. V. Smith, J.W. Akinwumi, and S.K. Ehui (2001). Agricultural Intensification and Efficiency in West Africa Savannahs: Evidence from Northern Nigeria. Socio-economic and Policy Research Working Paper 33. ILRI, Nairobi.
[25] Rahman, S. A. and Umar, H. S. (2009). Measurement of Technical Efficiency and Its Determinants in Crop Production in Lafia Local Government Area of Nasarawa State, Nigeria. *Journal of Tropical Agriculture, Food, Environment and Extension*, 8(2): 90 – 96.

*****