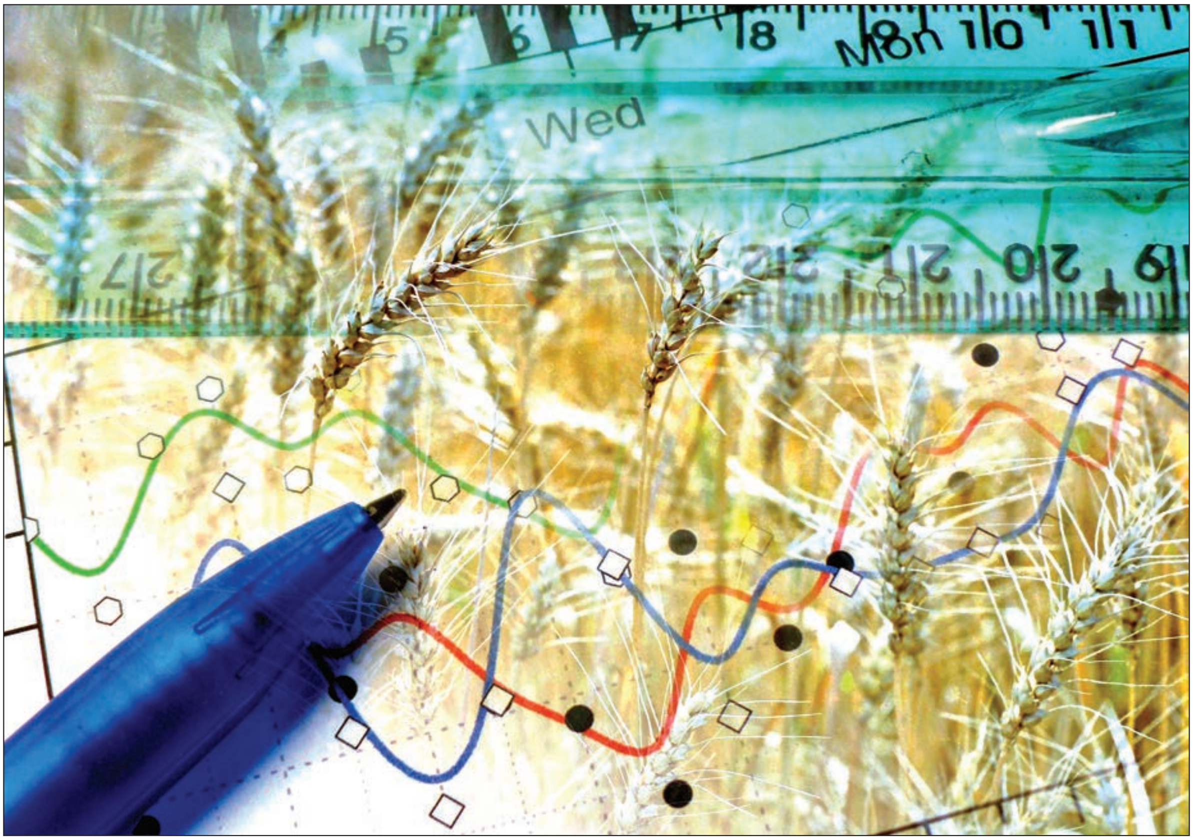

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Technical Efficiency in Maize Production and its Determinants: A Survey of Farms Across Agro Ecological Zones in Northern Nigeria

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ABSTRACT
Most researches on agriculture focused on how to achieve certain level of yield. However, few researches consider rational resource allocation to improve efficiency. Considering the need to increase agricultural productivity through proper utihzation of resources, this study measured the technical efficiency of maize production in northern Nigeria and identified the socioeconomic factors that determined technical efficiency in different agro ecological zones. The study was based on the conceptual framework that there is a relationship between input use and inefficiency in maize production in the area. Respondents were surveyed and data on input use, cost of production and yield were obtained. Stochastic frontier production function and Tobit models were used to analyze the data. The findings supported the conceptual framework that there is technical inefficiency in the use of inputs and certain socioeconomic factors contributed to inefficiency. The main contribution of the study is in measuring the technical efficiency of maize production from various States and modeling agro ecological zones to observe the impact of variation in climate and production practices on the technical inefficiency. The implication for the study is that farmers and policy-makers need to be rational on the use of inputs to achieve high level of technical efficiency.

Key words: Technical efficiency, stochastic frontier, maize, farm survey, northern Nigeria

INTRODUCTION
Maize crop belongs to the grass family (Poaceae). It is ranked first as the most important cereal crop in sub-Saharan Africa. It provides food for more than 1.2 billion people in addition to other uses. Nigeria with an annual production of close to 8 million metric tons in 2013 is the largest producer in Africa. Maize is the third most widely grown crop in Nigeria, following sorghum and millet. It is highly productive, cheap, less rigorous to produce and adapts to wide range of agro ecological zones (Babatunde *et al*., 2008). The rainforest agro-ecological zone of Nigeria is the major supplier of eating green maize, while the savanna zone in northern Nigeria comprising the (Derived Savanna, Guinea Savanna and Sahel) agro-ecological zones account for the large quantity of the pod (Ogunlade *et al*., 2010). Maize is not only an important cereal crop produced in Nigeria on the basis of output but also on the basis of number of farmers that produced it, as well as for its economic value (Olaniyi and Adewale, 2012). An estimated 4.2 million hectares were

harvested in 2013 with an average yield of 2 mt ha^{-1}. In addition to being an important source of food, many agro-based industries in Nigeria rely on maize as a source of raw material (Iken and Amusa, 2004).

From the foregoing discussion, it is evident that Nigeria's maize production industry is a growing diversified agricultural sector that holds the potential as a source of employment, food and raw material provision as well as enhancing non-oil export earnings, a vital policy for sustained national growth. In realization of the potentials of the maize industry, Nigerian government devoted considerable efforts to developing and disseminating information on viable production technologies, provision of better inputs and services for the local farmers to realize their full potential, in order to remain competitive in the international market. The Federal and State governments also as a sign of interest to develop the industry, committed substantial amount of resources, through various ministries and departments by providing financial and technical assistance such as loans, grants, transfer and adoption of new technologies, supply of inputs at subsidy and providing enabling environment.

Despite these efforts, yield per hectare for maize in Nigeria is as low as 2.0 mt ha^{-1} far lower than world average which is 5.1 mt ha^{-1}. One important reason that could explain this low productivity is inadequate physical infrastructure, poor resources, in addition to low literacy level which limits the ability of the farmers to understand improved production technologies and fully utilize opportunities, other elements that are missing in the maize sector, are vital information and organizational factors essential to drive effective strategy for sustained growth. For instance, efficiency of production, a measure of the ability of a production unit to produce maximum output using available resources in the best possible way, given certain technological constraints, is generally low in Nigeria compared to international standards. In view of these facts, it is evident that there is the need to raise the level of technical efficiency in order to improved maize productivity. It is therefore imperative to study the performance of maize production industry across individual farms with a view to assessing how the existing inputs are utilized and possibilities that abounds for improving efficiency.

Allocative efficiency (indicating the ability to optimize the use of inputs in various proportions giving their respective prices) and technical efficiency (the ratio between the observed and potential output of a production unit) are two indicators that are widely used to provide a rigorous measure of the efficiency of production of a unit/farm. This study focused on the later which is technical efficiency. Empirical studies that measured the efficiency of production of a particular crop, especially maize across states, spanning different agro-ecological zones are quite few in Nigeria. For instance Awotide and Agbola (2010) measured the relationship between land fragmentation and technical efficiency of maize farmers in northern Nigeria using Kaduna State as a case study. Obidi (2011) analyzed the technical and allocative efficiencies of maize production in northern Nigeria. Resource use efficiency among small scale irrigated maize farmers in north Taraba, northern Nigeria was estimated (Gani and Omonona, 2009). Similarly, profitability and production efficiency of small scale maize production in Niger State were measured (Sadiq *et al.*, 2013). Zalkuwi *et al.* (2010) considered the analysis of economic efficiency in maize production in Ganye local government area of Adamawa State. Technical efficiency at different levels of intensification among maize based farming households in Southern Guinea Savanna was estimated (Salau *et al.*, 2012). Results of these studies will no doubt be useful in formulating policies and plans that will increase the productivity, growth and development of the maize industry in Nigeria.

Despite efforts in various studies that analyzed the efficiency of maize production in northern Nigeria, none of the studies attempted to consider the efficiency of maize production at State level, across agro ecological zones. This study is the first regional scale study measuring technical efficiency of maize across 3 agro ecological zones covering 8 States and the Federal Capital Territory in northern Nigeria. The States covered by the study are Kaduna, Katsina, Kebbi, Kwara, Nassarawa, Niger, Sokoto, Zamfara and the Abuja the Federal Capital. Based on their geographical position, the States are classified into 3 agro ecological zones namely Southern guinea savanna covering (Nassarawa, Kwara and Abuja) northern guinea savanna which includes (Kaduna and Niger) and lastly the Sudan savanna encompassing (Katsina, Kebbi, Zamfara and Sokoto States). Attempt was also made to identify various socioeconomic factors that determines technical efficiency in the area. The result of this study is expected to identify States with low level of efficiency with a view to suggesting measures aimed at improving maize production efficiency. This study differs in scope from the previous studies in that it considers the entire States as the "Units" of production in addition, it also covers more than one ecological zone. This is aimed at assessing the effect of variation in climate on the determinants of technical efficiency of the States across agro ecological zones.

Against this background the main purpose of this study is to determine the technical efficiency of maize production in northern Nigeria. The study also intend to identify factors that could explain technical efficiency among the respondents.

More specifically this study aims to achieve the following objectives:

- To measure the technical efficiency level of maize farmers in northern Nigeria
- To identify the determinants of technical efficiency of maize production in northern Nigeria
- To examine the input cost structure of the maize farms

MATERIALS AND METHODS

Study area: The study uses farm level data obtained from maize farmers in some selected States of northern Nigeria. The area is made up of about 75% of the total area of Nigeria, it is located between latitudes 7° and 14° North and longitudes 3° and 15° East. It comprised of 19 out of the 36 States of Nigeria. With an estimated area of 692,826 km^2 it is a typical tropical region with high temperature all year round and an average annual rainfall of 500 mm. The area span across 3 agro ecological zones namely Southern guinea savanna, Northern guinea savanna and the Sudan savanna. Agriculture is the predominant occupation of the inhabitants mainly practiced at subsistence level using hand tools and simple implements. Major food crops grown in the area include millet, sorghum, maize, rice and cowpea. The agricultural potential of the area, threat of climate change and declining farm productivity makes the area more suitable for this study.

Sampling: The target population for this study consists of households who produce maize across northern Nigeria. The unit of analysis is the individual farmer. The sampling frame was a list of maize farmers maintained over several years by various ministries of agriculture and the village extension workers at the Local and the State governments' level. There was no alternative sampling frame available due to lack of adequate record of the target population in the area. Multi stage sampling was used, firstly States and Local government areas with large concentration of maize farming households were purposively selected. States and Local government areas were purposively selected based on their accessibility and high potential for maize production. This will enable the study include respondents with the desired characteristics, this method in addition to saving time and cost is also accurate and include only the respondents that are fit for the study. However, the method may sometimes be prone to bias.

Secondly, systematic random selection was used to select respondents in two local government areas of each of the selected States. Random sampling though not error free is quicker and ensures high representation of the respondents. To reduce the impact of low response and errors that could affect the usability of the surveys 700 respondents were chosen from the sampling frame. This was done to realize large sample for the analysis (Msuya *et al*., 2008; Mutoko, 2013; Dlamini *et al*., 2012; Kuwornu *et al*., 2013). A total of 530 questionnaires were realized in the final sample out of which 483 were usable, representing 75% response rate. The analysis included all the 483 questionnaires. Expedience method (that includes those respondents readily available) was used to determine the sample size. This is the only attainable option giving the exclusive circumstances of the study.

Data collection: Data for the main survey was collected in January 2013 via structured questionnaire. Before the actual survey the questionnaire was pre-tested on 40 respondents from the target population. The questionnaires were administered by trained enumerators, before conducting the survey, permission from each respondent was obtained. No incentives were provided to respondents to complete the questionnaires. The questionnaire survey was the only feasible option for data collection in view of the nature and the circumstance of the study (Battese, 1992; Dolton *et al*., 2003; Kuwornu *et al*., 2013; Etim and Okon, 2013).

Measurement and data analysis: State level data for 2012/2013 farming season collected via structured questionnaire was used for the study. The questionnaire was divided into four sections. Section A deals with questions relating to agricultural/environmental problems of the area. Section B pertains to issues of maize production, section C was on economic characteristics of the respondents and lastly section D take care of the respondent's demographic variables. The aggregate total output variable (Q) in the study was determine by gross maize production in (kg ha^{-1}). The input variables consist of 4 divisions' seeds, fertilizer, chemicals and labor. Seeds refer to planting seeds (kg ha^{-1}), fertilizer applied was measured (kg ha^{-1}), chemicals referred to quantity of chemicals applied, it was measured in L ha^{-1}. Labor was reported in man days ha^{-1}, indicating the total number of days spent in farming operations including land preparation, tillage and weeding, harvesting, processing and other farm operations. Average values of the variables recorded were presented in Table 1.

A two-step approach was used to analyze the data. Firstly stochastic frontier production function was used to determine the mean technical efficiency levels of the respondents and the contribution of each input to productivity. Cobb-Douglas function was considered instead of other functional forms for it provides the most robust fit for the data. Consequently the stochastic frontier function model for the study is specified as:

Model specification:

$$\ln Q_i = \beta_0+\beta_S \ln S+\beta_F \ln F+\beta_C \ln C+\beta_L \ln L+v_i-u_i \quad (1)$$

where, βi's is parameters to be estimated, S is planting seeds, F is fertilizer, C is chemicals and L is labor.

To identify the determinants of technical inefficiency at the second stage inefficiency scores were obtained by subtracting the efficiency scores obtained at the first stage from 1. Inefficiency scores are therefore equals to 1−efficiency scores. The inefficiency scores are then regressed against the farm specific variables using the Tobit model which defines the inefficiency effect model. The Tobit model was developed as:

$$Yi^* = \beta 0+\beta 1iZ\ 1i+\beta 2i\ Z2i+\beta 3i\ Z3i+\beta\ 4iZ4i+\beta\ 5i\ Z5i+\beta\ 6i\ Z6i \quad (2)$$

where, Yi* is technical efficiency ratio, Z is education, Z2 is credit, Z3 is farm power, Z4 is house size, Z5 is market and Z6 is a dummy for Agro ecological zones (1= Sudan savanna, 2 = Northern guinea savanna, 3 = Southern guinea savanna).

RESULTS

Descriptive statistics: The summary statistics for the variables used in the study were presented in Table 1. The result showed that the average yield of maize obtained is 2306 kg ha^{-1}. The minimum value is 100 kg ha^{-1} and the maximum is 5400 kg ha^{-1}. The average values for seeds and fertilizer inputs ranges between 0.36-2.23 and 3.0-743.93 kg ha^{-1}, respectively. The average value for chemicals used was 7.89 L ha^{-1}, it ranges between a minimum of 0.6 L ha^{-1} to a maximum of 27.2 L ha^{-1}. The average figure for labor is 86.51 man days ha^{-1} with a range of 2.45 man days ha^{-1} to 126.25 man days ha^{-1}. The average years of education are 4.8 years, with a minimum of 0 and maximum of 16 years. The average figure for credit in cash is ₦11,987 the value range between 0 to ₦2,000,000. The average distance to input market was 10.87 km, it ranges between a minimum of 1 km to a maximum of 50 km. Farm power is used as a categorical dummy, it is within the bounds of 1-3 with an average of 1.92. The average the size of the household was 8.0 persons with a minimum range of 1 person and maximum of 40 persons.

Estimates of the frontier production function model: The mean technical efficiency score was presented in Table 2. The mean technical efficiency for the sample was found to be 84% this could be compared with 78% reported by Salau *et al.* (2012) for Southern guinea savanna of Nigeria. Obidi (2011) in a study of maize efficiency in northern Nigeria obtained 90% mean efficiency. Similarly, Dlamini *et al.* (2012) in separate study of technical efficiency for maize in Swaziland found the mean efficiency score to be 80%. The values for the maximum likelihood estimate for the stochastic frontier model were also shown in Table 2. The results showed the value for the variance

Table 1: Descriptive statistics for the variables used in the study

Variables	Minimum	Maximum	Mean	Standard deviation
Output (kg ha^{-1})	100	5400	2290	1011.17
Seed (kg ha^{-1})	0.36	7.5	2.235	1.28
Fertilizer (kg ha^{-1})	3.0	743.93	185.37	144.82
Chemical (L ha^{-1})	0.6	27.2	7.89	4.34
Labor (Man days ha^{-1})	2.45	126.25	86.51	14.20
Socioeconomic characteristics				
Education (Years)	0	16	4.8	5.57
Credit (₦)	0	2,000000	11987	97517
Market (Distance in km)	1	50	10.87	9.26
Farm power (Dummy)	1	3.0	1.92	0.81
House size (Persons)	1	40	8.05	5.41

₦: Naira the Nigerian currency

Table 2: Maximum likelihood estimates for the parameters of stochastic frontier model

Variable	Coefficient	Standard-error	t-ratio
β_0	1.239***	0.111	11.093
Seed (kg)	0.245***	0.070	3.479
Fertilizer (kg)	0.279***	0.024	11.562
Chemicals (L)	0.136***	0.038	3.540
Labor (h)	0.509***	0.048	10.596
Variance parameters			
Sigma-squared	0.073***	0.009	7.835
Gamma	0.677***	0.086	7.855
Log likelihood	84.497		
Mean technical efficiency (%)	84		

***p-value significant at 1% level

ratio parameter λ which is the (ratio of the variation of individual output from his maximum possible frontier output as a result of technical inefficiency rather than random variability), this value is 0.677 this showed that 67% of the difference between the observed and the actual output were basically due to technical inefficiency of farms.

In addition the estimated value of σ^2 was 0.073, shows that the difference between the observed output and the potential (frontier) output is due to inefficiency and not chance alone. Both gamma and sigma squared are statistically significant at 1%. The elasticities of inputs generated from the stochastic frontier model were as follows seed (0.245), fertilizer (0.279), chemicals (0.136) and labor (0.509). The result further indicated that the return to scale parameter obtained by summing up the coefficients for the inputs is 1.169. Labor had the largest elasticity, followed by fertilizer and then seeds while chemicals had the smallest elasticity. All the inputs showed a positive impact on productivity and were statistically significant at 1% level; this underscores the importance of all the inputs to maize productivity in northern Nigeria.

Estimates of technical efficiency for agro ecological zones: The mean scores for the technical efficiency from the agro ecological zones covered by the study were also estimated in Table 3. The values do not radically vary between the agro ecological zones, the Southern guinea savanna had the highest mean efficiency score (86.7%) followed by the Sudan savanna with a mean value of 83.8% and lastly the Northern guinea savanna which had an average of 83.4%.

Determinants of technical inefficiency: The Tobit model regression estimates for the determinants of technical inefficiency were presented in Table 4. Education, credit, farm power, house size and market variables had a negative coefficients implying that they contributed negatively to technical inefficiency (increase technical efficiency) the coefficient for credit is significant at 1% level while the variable for education is statistically significant at 5% level. All the coefficients had the expected negative signs as the variables are expected to contribute in reducing technical inefficiency. Credit had the highest contribution in reducing technical inefficiency, followed by farm power, education, house size and lastly market. The result showed that credit reduces technical inefficiency index by 7%, farm power by 0.49%, education reduces inefficiency by 0.11%, house size by 0.032% and market had the least contribution in reducing technical inefficiency with a value of 0.019%.

Table 3: Frequency distribution of technical efficiency level by agro ecological zones

Agro ecological zone	Average technical efficiency (%)	Min. TE (%)	Max. TE (%)
Southern guinea savannah	86.7	54.02	97.17
Northern guinea savannah	83.4	48.00	96.92
Sudan savannah	83.8	58.00	93.66

Table 4: Estimates of Tobit model for the determinants of technical inefficiency

Variables	Coefficient	Rob. Std. error	t-value	p>t
Education	-0.1177980**	0.0555109	-2.12	0.034
Credit	-7.18E-060***	1.88E-060	-3.82	0.000
Farm power	-0.4957314	0.4069656	-1.22	0.224
House size	-0.0322966	0.0585724	-0.55	0.582
Market	-0.0194757	0.0301103	-0.65	0.518
Agro ecological zones				
2	-2.6424910***	0.7904712	-3.34	0.001
3	0.2110903	0.7957720	0.27	0.791
Cons	18.7367800	1.1223870	16.69	0.000
Sigma	7.0623480	0.3783744		

,*p-values significant at 5 and 1%, respectively

Table 4 also showed the result for the agro ecological zones, a series of dummies for agro ecological zones were included in the Tobit model to capture the impact of variation in technical efficiency between agro ecological zones since differences in climate, soil and socioeconomic characteristics as well as productivity could exist among respondents from different agro ecological zones. The result showed that the predicted value for the technical efficiency is 2.642% lower for the respondents in Northern guinea savanna (agro ecological zone = 2) than for the respondents in Sudan savanna (agro ecological zone = 1). The coefficient for Northern guinea savanna was also statistically significant at 1% level. The result further showed that the predicted value of technical efficiency is 0.21% higher for the respondents in southern guinea savanna (agro ecological zone = 3) than for the respondents in the Sudan savanna (agro ecological zone = 1). This support the results obtained by the study on technical efficiency scores for agro ecological zones presented in Table 2.

Input cost structure: Analysis of the input cost share based on the data from the study showed that labor accounts for about 75% of the total input cost. This indicated that labor is the most critical input factor for maize production in northern Nigeria. The input with the second highest share of total input was fertilizer accounting for 22.8%, followed by chemicals with 1.5% and lastly seeds which comprised of less than 1% of the total share. Comparing the average input cost/ha between States Fig. 1 showed that of all the inputs labor had the highest share in all the States. Nassarawa State however had the highest labor cost of ₦127213 ha^{-1} followed by Kebbi State with ₦114277 ha^{-1}, Kwara had ₦97,735 ha^{-1} and the State with the least labor cost is Kaduna State with ₦65640 ha^{-1}. On fertilizer cost Kebbi had the highest cost with ₦40,371 ha^{-1}, followed by Nassarawa State ₦32,272 ha^{-1}, the Katsina State got ₦30,168 ha^{-1} and Kwara had the least cost of fertilizer with ₦16443 ha^{-1}. On the cost of chemicals Abuja got the highest figure of ₦4,706 ha^{-1} followed by Niger State with ₦3,497 ha^{-1} then Zamfara had ₦2,476 ha^{-1} the State with lowest cost of chemicals is Kwara with ₦843 ha^{-1}. Cost of seeds is the lowest among all inputs, however

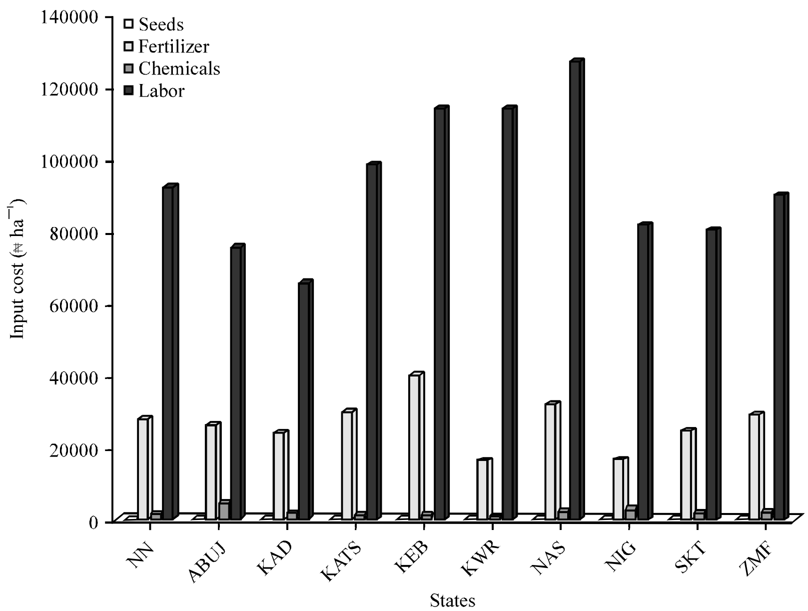

Fig. 1: Input cost structure by States

comparing seed cost among States Abuja had the highest figure with ₦404 ha^{-1} followed by Nassarawa State with ₦151 ha^{-1} then Kaduna State with ₦116 and ₦65 ha^{-1} for Kwara State which has the least cost.

DISCUSSION

To understand the contribution of inputs to productivity and technical efficiency of maize farms, the paper investigated the technical efficiency of maize farms in 8 States of northern Nigeria and the Federal Capital Territory covering 3 agro ecological zones. The study also identified the determinants of technical inefficiency in the area. Input cost structure for maize production sector was also assessed. The study contributed to agricultural literature by demonstrating the relevance of technical efficiency in the ambience of agricultural productivity. Technical efficiency model for maize production was developed and tested using farm level data from the selected States in northern Nigeria by stochastic frontier production technique. An exceptional contribution of the study was the inclusion of the agro ecological zone dummy to reflect the effect of climatic variation from different agro ecological zones on the technical efficiency of maize production in the area.

The current study empirically measured technical efficiency of maize production from sample of respondents in the area. Respondents were found to achieve an average technical efficiency of 84%. The findings indicated that although the technical efficiency of resource use is high inefficiency still existed in the maize sector and with more optimal input use, technical efficiency could be raised by 16%. It was also observed from the results that the coefficients for all the inputs tested i.e., seeds; fertilizer, chemicals and labor were statistically significant at 1% level. This underscores the importance of all the inputs to maize productivity and technical efficiency. The results further revealed that addition of 1% of seed raises technical efficiency by 24%, addition of 1% of fertihzer increases technical efficiency by 27% and for each 1% of chemicals applied technical efficiency increased by 13% while labor raised efficiency by 50%. The high elasticity for labor shows that maize production is a labor intensive operation and labor is an essential input for maize production.

In addition, the value of the return to scale parameter obtained by summing the coefficients was 1.169, this showed that maize production in northern Nigeria exhibit a constant to return scale, suggesting that farmers in the area largely uses traditional farm practices which may results to low productivity but could be improved with better technology. Estimate of the variance ratio parameter showed that 67% of the difference between the observed and actual output are due to inefficiency not chance alone. Building from the findings above the result further revealed that about 73% of the observed inefficiency is under the control of farms in the states. This is in line with the findings of previous studies that estimated the technical efficiency of maize production (Kuwornu *et al.*, 2013; Dlamini *et al.*, 2012; Kwarteng and Towler, 1995).

Similarly results of the inefficiency effect Tobit model presented in Table 4 revealed that several socio economic factors are important contributors in reducing technical inefficiency (increasing technical efficiency) of the respondents. The variables of credit, education, farm power, house size and distance to market were found to be negatively related to technical inefficiency. This result is consistent with the findings of similar studies on technical efficiency of maize production (Olowa and Olowa, 2010; Parikh *et al.*, 1995; Wadud and White, 2000; Amaza and Maurice, 2005). The variables for education and credit were significant while farm power, house size and market variables were insignificant. This might be explained by the divergent impact of the variables on technical efficiency levels.

The variable for house size a proxy for labor was insignificant this could be due to the marginal productivity of the household and mismanagement of time allocated to different farm operations. Hired labor could also be less productive if not properly supervised these reasons might lead to underutilizing valuable human resource and consequently low efficiency, this is consistent with the result of Msuya *et al.* (2008). Farm power variable was also statistically insignificant. The variable indicated the level of mechanization of the respondents involving use of either hand, animal or machine dummy as a source of farm power. The non-significance of the findings could be as a result of the fact that most farmers relied on hand as a source of farm power, this was followed by the farmers that employed the use of animals. Very few farmers have access to tractors which are not always readily available. The non-significance of the findings indicates that although the level of farm power usage contributed in reducing inefficiency, it is not an important determinant of efficiency. A non-significant result was also obtained for distance to market variable.

One aspect which illustrates the nature of farm resource use is the result for the technical efficiency of farms from different agro ecological zones. The coefficient for the Southern guinea savanna showed that respondents from the zone (agro ecological zone = 3) are more technically efficient than the respondents from the Sudan savanna (agro ecological zone = 1). Similarly respondents from the Northern guinea savanna (agro ecological zone = 2) are less technically efficient than the respondents from the Sudan savanna (agro ecological zone = 1). In addition coefficient for the Northern guinea savanna also showed a significant relationship with technical inefficiency. This result makes the respondents from Southern guinea savanna the most technically efficient, followed by respondents from the Sudan savanna. Variation in the level of technical efficiency between respondents from different agro ecological zone could be explained by differences in crop production practices, soil fertility and climatic factors which vary between the zones. Higher technical efficiency of the respondents from the Southern guinea savanna might be explained by having better access to tractors fertile soils as well as moderate amount of rainfall in the last few years. The average size of their farm holding is also smaller this could enable them manage their farms and resources more efficiently. The findings agree with (Onoja and Achike, 2008; Kuwornu *et al.*, 2013).

The next section provides a general discussion on the input cost structure. Among the inputs used labor made up the highest cost, this could be explained by the scarcity of labor during the farming due to heavy reliance on human work force as a source of farm power. Maize production is also labor intensive and cultural practices requires longer hours to accomplish. These factors may lead to high percentage in the share of cost for labor. Fertilizer accounts for the second highest share in the cost of input, high fertilizer requirement by maize, shortage of the commodity, lack of subsidy and heavy reliance on import may account for this high percentage in share of cost. Chemicals had low percentage in the share of cost, this could be due to the fact that not all respondents use chemicals due its high price, poor knowledge on its usage or lack of confidence on the efficacy of the chemicals, this may explain its low demand.

Seeds have the least percentage in the share of inputs this could be because most farmers relied on seeds from the previous harvest for planting in the subsequent year, also maize have lowseed rate per hectare and farms require less seeds to plant. Most farmers also avoid the costly hybrid seeds all these factors may explain the low percentage in the share of cost. For all the inputs labor had the highest cost in all the States, Nassarawa State however, had the highest labor cost of ₦127,213 ha^{-1} and Kaduna State had the least ₦65,640. This could be due to its close proximity with the federal capital Abuja where labor is expensive. Kebbi has the highest cost of fertilizer usage/ha heavy demand for the input due to poor soils in some part of the State may account for this results. High weed infestation may explain the reason why Abuja had the highest cost of chemicals this was substantiated by the respondents during the survey interview.

CONCLUSION

To conclude, this study has addressed a number of significant issues. First, technical efficiency of maize production in northern Nigeria for 2012 farming season was estimated. All the inputs tested were found to contribute to maize productivity with labor providing the largest contribution. Secondly, from all the agro ecological zones, an average efficiency level of 80% and above was achieved, the Southern guinea savanna had the highest average technical efficiency level (86%) showing that Sudan savanna and the Northern guinea savanna stands to benefit more from policies that will raise technical efficiency. Thirdly, education and credit were the important socioeconomic factors that contributed in reducing technical inefficiency. Labor got the highest share of cost in all States, again signaling the importance of labor as a determinant of success in maize production. This study differs from previous studies that examined the technical efficiency of maize production in northern Nigeria in 3 important ways. First, the analysis included most of the entire area of northern Nigeria, mainly regarded as the corn belt of Nigeria. Second, Maize, the third most important cereal crop in Nigeria is considered; lastly, in order to examine the variation in technical efficiency due to differences in climate, a dummy for agro ecological zone was modeled. The evidence presented in this study clearly showed that inefficiency existed in the maize production industry in northern Nigeria and with more efficient use of inputs, productivity could be raised significantly. The current analysis was limited to maize crop prospective researchers should consider other important crops and endeavor to cover the entire country.

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