Profitability and Technical Efficiency of Soybean Production in Northern Nigeria

O.O. Ugbabe*[1], T. Abdoulaye[2], A.Y. Kamara[2], J. Mbavai[3] & O. Oyinbo[1]

Keywords: Profitability- Efficiency- Soybean production- Nigeria

Summary

The International Institute of Tropical Agriculture and collaborating partners have been introducing and disseminating short season soybean varieties among farm households in the Sudan savannas of Northern Nigeria since 2008. Yet, there is no empirical information on the profitability and technical efficiency of soybean production. This study estimated the profitability and efficiency of production of the early maturing soybean. Nine hundred soybean farming households in thirty communities from three Local Government Areas (LGAs) in Kano State were sampled for the study. Partial budget technique and stochastic frontier production function were used to analyze the data elicited from the sampled farm households. Results from the study established the profitability of soybean production in all the three LGAs of Kano State. The highest profit of N178, 613/ha and returns per naira invested of 2.5 respectively was earned by the soybean producing households of Dawakin-Tofa LGA. Net profit was N157,261 in Shanono with a returns of 1.75 per naira invested. In Bunkure, net benefit was N143,342 with returns of 1.66 per Naira invested. The mean technical efficiency was highest for the Dawakin-Tofa LGA soybean growing households (87%), followed by Bunkure LGA (68%), and Shanono LGA (59%). This result implies that given the current level of resources available to the soybean producing households, they can increase their soybean output in the short run by a margin 13%, 32% and 41% in Dawakin-Tofa, Bunkure and Shanono LGAs respectively through efficient utilization of their available resources. Farmer-specific efficiency factors, which comprise age, education, access to credit, extension contact and farming experience, were found to be the significant factors that account for the observed variation in efficiency among the farmers in the 3 LGAs. It was recommended that the soybean farmers through the assistance of extension agents should be encouraged to adhere strictly to the recommended

Résumé

La rentabilité et l'efficacité technique de la production du soja dans le nord du Nigeria

Depuis 2008, l'Institut International d'Agriculture Tropicale et ses partenaires ont introduit et diffusé des variétés hâtives de soja chez les agriculteurs des savanes soudaniennes dans le nord du Nigeria. Aucune donnée empirique sur la rentabilité et l'efficacité technique de la production de soja n'est encore disponible d'où l'intérêt de cette étude qui a évalué ces paramètres pour les variétés de soja introduites dans la région. Les échantillons ont été collectés chez neuf cent agriculteurs appartenant à 30 communautés de trois districts de l'État de Kano. La technique du budget partiel et le modèle de frontière de production stochastique ont été utilisés pour analyser les données. Les résultats ont montré que la production de soja était rentable dans les trois districts de l'État de Kano. Les bénéfices et les retours par naira investi les plus élevés ont été obtenus dans la zone de Dawakin-Tofa LGA. Le bénéfice net le plus élevé de 178,613 N/ha et le retour par Naira investi le plus important de 2,5 ont été observés dans la zone de Dawakin-Tofa. Le bénéfice net a été de 157,261 N avec un retour de 1,75 par naira investi dans la zone de Shanono. Pour la zone de Bunkure, le bénéfice net était de 143,342 N avec un retour de 1,66 par Naira investi. La moyenne de l'efficience technique était plus élevée chez les agriculteurs de la zone de Dawakin-Tofa LGA (87%), suivie par ceux de la zone de Bunkure LGA (68%), et afin ceux de la zone de Shanono LGA (59%). Ces résultats montrent que les agriculteurs peuvent améliorer leur marge bénéficiaire, compte tenu du niveau actuel des ressources disponibles. La production peut augmenter à court terme avec une marge bénéficiaire de 13%, 32% et 41% respectivement dans les zones de Shanono, Bunkure et Dawakin-Tofa grâce à une amélioration de l'efficience de l'utilisation de leurs ressources. Les

[1]Ahmadu Bello University, Institute for Agricultural Research, Zaria, Nigeria.
[2]International Institute of Tropical Agriculture, Ibadan, Nigeria.
[3]Bayero University, Faculty of Education, Kano, Nigeria.
*Corresponding author: ougbabe@yahoo.com

Received on 22.02.15 and accepted for publication on 10.03.17

soybean production practices towards ensuring efficient utilization of their available resources so that they can improve their technical efficiency and increase their profit level towards enhancing their household food security.

facteurs d'efficacité propres aux agriculteurs, qui comprennent l'âge, l'éducation, l'accès au crédit, les contacts de vulgarisation et l'expérience en agriculture, ont été considérés comme les plus importants pour expliquer la variation d'efficacité observée chez les agriculteurs des 3 districts. Il est conseillé que les producteurs de soja par l'intermédiaire des agents de vulgarisation soient encouragés à se conformer strictement aux pratiques recommandées de production du soja afin d'assurer une utilisation efficace de leurs ressources disponibles en améliorant leur efficacité technique et en accroissant leur niveau de profit pour assurer la sécurité alimentaire de leur foyer.

Introduction

The cultivation of soybean is increasing in the savannas of Nigeria because it's a major cash crop widely used in food and feed (10, 28). The crop provides opportunity to diversify the cereal cropping systems in the savannas of West Africa. Soybean production is increasing because of its numerous benefits. Soybeans contain about 40% of protein and are more protein-rich than any of the common animal feedstuffs found in Africa. Mixed with cereals, the resulting diet meets the standards of the United Nations Food and Agriculture Organization (FAO) (12). Soybean also contains about 20% oil, which is 85% unsaturated and cholesterol free. Soybean-fortified food products not only have more protein and minerals than their non-fortified counterparts, they are considerably cheaper than other sources of high-quality protein for rural communities such as fish, meat, milk, and protein-rich legumes. Farmers have adopted new cultivars developed at International Institute of Tropical Agriculture (IITA) (21) that store well and unlike cowpea, do not need chemical pest control. They also nodulate freely with native rhizobia strains and take care of their proportion of their nitrogen (N) requirement through biological nitrogen fixation once the plants are established (21). Soybean has become a major cash crop in the Guinea savannas in northern Nigeria. Significant differences in average income have been reported for adopters of soybean varieties with an income of N 7,768 (US$61) per year as against N 6,834 (US$54 per year) by non-adopters (20). On human capital, 49% adopters invested in children's education compared to 27.5% for non-adopters due to higher income of the adopters. Soybean production has increased dramatically more than seven fold between 1980 and 2008 according to data from FAO (29). The corresponding increased levels of consumption have improved nutrition particularly among the urban poor and middle income groups (28). The increase in soybean production was particularly higher in Nigeria. Nigeria currently produces about 600,000 Mt of soybean per year. The two main products from soybean processing are oil and meal. The oil is sold through major markets by wholesalers who in turn sell to distributors and supermarkets. The meal is bought by feed millers direct from the processors and transported to the feed mills and used as protein ingredient in feed mixture and sold to livestock producers particularly the poultry sub-sector. There are good prospects for expanding production in the savanna areas of Nigeria, where it shows significant economic and soil fertility restoration benefits over other crops especially cereals. Traditionally, small-scale farmers grow soybean as a sole crop; intercropping is rarely practiced. Potential soybean grain yields are as high as 3615 kg ha^{-1} in tropical Africa (11). The promiscuous soybean lines that are now available produce about 2.5 t of grain and 2.5 - 4 t of forage ha^{-1} and there is every indication that further progress can be made. They fix between 44 and 103 kg N ha^{-1} of their total N and have an estimated net N balance input from fixation following grain harvest ranging from -8 for the traditionally grown varieties to +43 kg N ha^{-1} for some improved soybean varieties (27).

In Nigeria, soybean is traditionally grown in the Guinea savannas where rainfall amount and length of growing period are sufficient for the cultivation of the largely medium to late maturing varieties. Because of the cash value and potential for home consumption, farmers in the drier Sudan savannas around Kano, Katisna, Bauchi and Zamfara States also grow some soybean. They however, mostly grow the available late maturing varieties which has a high risk of failure if the rains stop earlier in the season because the Sudan savannas have short growing seasons. The production of soybean in the Nigerian Sudan Savannas can be enhanced through vertical (productivity) and horizontal (area) growth. However, considering the limiting land resource in northern Nigeria, emphasis is placed on increased productivity through use of improved production technologies which efficiently utilise the available productive resources.

Several soybean production technologies including improved varieties, crop management and protection techniques have been continuously generated by agricultural research system and disseminated to farmers for enhancing productivity and profitability. To promote cultivation of soybean in the Sudan Savannas, the Sudan Savanna taskforce of the Kano-Katsina-Maradi Pilot Learning Site (KKM-PLS) program introduced in the cereal-legume-livestock Innovation Platforms (IPs), early maturing and rust resistant soybean varieties that are suitable for cultivation in short-season environments. The project trained lead farmers drawn from several community-based organizations (CBOs) to grow soybean using improved production techniques. The varieties were sourced from the IITA and distributed to the CBOs through the Agricultural Development Programs in Kano and Katsina States. To drive production, the farmers were also linked to industrial processors and local buyers so that soybean can be sold at farm gate at acceptable prices. To promote local consumption, women from the selected communities were provided training in the processing of soybean into various local food products.

The benefits associated with the introduced soybean technologies to smallholder farmers have not been determined. The escalation of the costs inputs especially fertilizers, crop protection chemicals and land rent in northern Nigeria affect benefits of crop production enterprise. It is therefore, important to make serious economic consideration when evaluating production technologies before being recommended for use by the farmers, rather than just evaluating for technical potential. Farmers usually choose and use technologies that are within their technical and economic capacities. Resource-use efficiency measures are important indicators of the viability of any agricultural activity and hence the economic performance of any technology and producer. Efficiency levels can be used to select the most cost-effective input use options and to determine the magnitude of gains that could be obtained by improving efficiency of the existing production technologies (Yegon *et al.* (32)). This can provide farmers with criteria for adjusting the levels of inputs use for maximizing benefits. In a study on determinants of technical efficiency of medium-scale soybean farmers in Benue State, Nigeria, Otitoju and Arene (25) found that the average technical efficiency of the farmers was about 73% and factors such as sex, age and farming experience were significant in influencing their technical efficiency. In another study in Benue State, Nigeria, Aye and Mungatana (5) reported that hybrid seed was found to have positive and significant impact on technical efficiency. Other policy variables that had significant impact on technical efficiency include education, extension, credit and land. Yegon *et al.* (32) estimated the technical efficiency levels and inefficiency factors of soybean producers in Western Kenya. They found that education level, occupation, age and gender affected technical inefficiency. Education level and occupation had negative effects while age and gender had positive effects on inefficiency. Amaza *et al.* (4) from their study in Borno State Nigeria found the mean farmers' technical efficiency index to be 0.68 and farmer-specific efficiency factors (sex, age and farming experience) accounted for the observed variation in efficiency among the farmers.

Since the introduction of improved soybean varieties by IITA through the Sudan Savannah task force between 2008 - 2010, there has been no empirical study to determine the profitability and technical efficiency of soybean production in the Sudan savannas. This constitutes a gap in research that formed the basis for this study. Hence, to fill the knowledge gap and gain better insight on the status of soybean in the Sudan savannas, this study was carried out to establish the profitability and technical efficiency of soybean production in northern Nigeria.

Methodology

The data for this study were obtained through a household survey that was conducted in January 2015. The main instrument for data collection was a structured questionnaire administered on households by trained enumerators under the supervision of IITA. The modules of the questionnaire included socioeconomic characteristics, quantity of inputs and outputs, costs of inputs and outputs. Also, quarterly soybean price data was obtained from National Agricultural Extension and Research Liaison Services (NAERLS). Three Local Government Areas (LGAs) in Kano State were covered for the purpose of data collection. These consist of Bunkure, Shanono, and Dawakin-Tofa LGAs. Ten villages were selected in each LGA and thirty farming households were randomly selected per village. The total sample size for the study was 900 soybean farming households. The Sudan Savanna taskforce of the KKM-PLS program established field demonstrations in selected communities to show-case the performance of the short-season varieties and the late maturing variety (TGX-1448) which is extensively cultivated in the Guinea savannas was used as control. Farmers were taught to grow soybean in rows at a recommended planting density of 266,666 plants ha^{-1} between late June and early July. They were advised to use phosphorus fertilizer in the form of single superphosphate at the rate of 60 kg P_2O_5 ha^{-1} and the farmers followed all the field operations up to the harvesting, threshing and packaging.

The partial budget technique and the stochastic frontier production function were used to estimate the profitability and the technical efficiency of soybean production respectively. The partial budget technique provides actual information on farm-input use and their costs, output and output prices, and farmers' gross margins. The gross margin indicates the returns to farmers' resources, which consist of land, labor, capital, and other production inputs. The procedure involved the estimation of the costs and returns from soybean production data based on 2014 crop production season. To estimate the gross margin, data on production cost and gross revenue from soybean outputs were collected from the sampled farmers. In estimating the production cost, family labor cost which was not paid for by the farmers, was estimated as its opportunity cost by using the market wage rate for labor in the study area. The gross margin from soybean production activities is the gross value of soybean outputs less all the variable costs incurred on soybean during the production year (2014).

One of the tools in economics used to determine the economic benefits of technologies is partial budget analysis. A budget is a farm management method that is intended to assist researchers, extension agents, and farmers in the decision-making process. It is a tool that aims at quantifying and assessing the effects of a proposed technology on crop production. Results from partial budget analysis assist agricultural scientists in identifying weaknesses (high cost and/or low income) of the technology being developed. Partial budget analysis aids scientists and extension agents in deciding which technology to recommend to farmers. Partial budget analysis shows the level of profitability and helps to decide whether to adopt a new technology or not. Budgeting forces management to think ahead, and aid sound decision-making. Partial budget analysis can apply to all crops and cropping systems (2). The data was analyzed using the partial budget technique.

Efficiency can be defined as the relative performance of the process used in transforming input into output (16). It can be defined as the attainment of production goals without waste. Agricultural productivity depends on how factors are efficiently used in the production process. Technical efficiency is defined as the ability to produce a given level of output with minimum quantity of inputs under a certain technology. It reflects the ability of a farm to obtain maximum output from a given level of inputs (14). According to (17) technical efficiency is just one component of overall economic efficiency. Profit maximization requires a firm to produce the maximum output given the level of inputs employed (technical efficiency). "The level of technical efficiency of a particular firm is characterized by the relationship between observed production and some ideal or potential production (15).

The measurement of firm specific technical efficiency is based upon deviations of observed output from the best production or efficient production frontier. If a firm's actual production point lies on the frontier, it is perfectly efficient. If it lies below the frontier then it is technically inefficient, with the ratio of the actual to potential production defining the level of efficiency of the individual firm. There are several important reasons for measuring the farm level technical efficiency of agricultural production. Firstly, if farmers are not making efficient use of existing technologies, then efforts designed to improve efficiency would be more cost effective than introducing a new technology as a means of increasing output (30). Secondly, identification of sources of inefficiency is important to the institution of public and private policies designed to improve performance of agriculture (9).

Empirical models

Estimation of gross margin

The gross margin is estimated as given by equation I (24).

$$GM = \Sigma piqi - \Sigma rjxj \qquad \text{(I)}$$

Where:
GM= farm gross margin,
p_i= unit price of output i,
q_i= quantity of output i,
r_j = unit cost of variable input j,
x_j = quantity of the variable input j.

Stochastic frontier production function

Although, there are different functional forms of stochastic frontier, the data was fitted to Cobb-Douglas and translog functional forms using frontier version 4.1 software and the most preferred functional form was selected based on the result of generalized likelihood ratio test as used by Otitoju *et al.* (26).

The empirical model of the stochastic frontier Cobb-Douglas and translog functional forms in the analysis of technical efficiency of soybean production is specified explicitly in equations II and III respectively as given by Battese and Coelli (6).

$$\ln Y_i = \ln\beta_o + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + V_i - U_i \qquad \text{(II)}$$

$$\ln Y_i = \ln\beta_o + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + ½\, \beta_{11}(\ln X_1)^2 + ½\, \beta_{22}(\ln X_2)^2 + ½\, \beta_{33}(\ln X_3)^2 + ½\, \beta_{44}(\ln X_4)^2 + \beta_{12}[(\ln X_1)x(\ln X_2)]^2 + \beta_{13}[(\ln X_1)x(\ln X_3)]^2 + \beta_{14}[(\ln X_1)x(\ln X_4)]^2 + \beta_{23}[(\ln X_2)x(\ln X_3)]^2 + \beta_{24}[(\ln X_2)x(\ln X_4)]^2 + \beta_{34}[(\ln X_3)x(\ln X_4)]^2 + V_i - U_i \qquad \text{(III)}$$

Where:
Y_i = Output of soybean in kilograms,
X_1= Farm size in hectare,
X_2= Quantity of seed in kilograms,
X_3= Quantity of fertilizer in kilograms,
X_4= Labour in man-days,
V_i= Random variability in production that cannot be influenced by the farmers,
U_i= Deviation from maximum potential output attributable to technical inefficiency,

β= vector of production function parameters estimated.
ln= natural logarithm

The *a priori* expectations of the relationship between farm size, seed, fertilizer and labour with the output of soybean is that their estimated coefficients should be positive.
The inefficiency model is stated in equation III (6).

$$U_i = \alpha_0 + \alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3 + \alpha_4 Z_4 + \ldots + \alpha_8 Z_8 \quad (3)$$

Where:
U_i= technical inefficiency effect of the ith soybean farmer,
Z_1= Age of the farmers (years)
Z_2= Marital status (Dummy: 1 married, 0 otherwise)
Z_3= Level of formal education (years of formal schooling)
Z_4= Household size (number of the members of a given household)
Z_5= Farming experience (years of experience)
Z_6= Extension contact (frequency of extension contacts)
Z_7= Membership of association (years of participation in farmer associations)
Z_8= Access to credit (amount of credit obtained in naira)
α= parameters estimated.

On the assumption that V_i and U_i are independent and normally distributed, the parameters namely β, α, σ^2 and γ were estimated by the method of Maximum Likelihood Estimates (MLE). A significant value of sigma squared (σ^2) indicates a good fit and the correctness of the specified distributional assumption of the composite error terms in the estimated models. Also, a significant value of gamma (γ) for the estimated models indicates the shortfall below the frontier output of the soybean farmers that was due to the inefficiencies of the farmers. The *a priori* expectations of the variables of the inefficiency effect model (Z_1-Z_8) are that their estimated coefficients should be negative.
The generalized likelihood ratio test statistic was calculated in equation IV.

$$\lambda = -2ln[L(H_0) - L(H^1)] \quad \text{(IV)}$$

$L(H_0)$ is the value of the likelihood function for the frontier model in which parameter restrictions specified by null hypothesis are imposed and $L(H_1)$ is the value of likelihood function of the frontier model. If H_0 is true then λ has approximately a *chi-square* distribution with degrees of freedom equal to the difference between the parameter estimated under H_0 and H_1 respectively.

Results and discussion

The result presented in table 1 show the basic statistics of inputs and output of soybean production and the socioeconomic characteristics of the soybean farmers. The average output of soybean was 2216.45 kg, seed was 7.55 kg, farm size was 1.24 ha, fertilizer was 210.55kg and labour was 52.25 man-days. The output of soybean and fertilizer input were higher in comparison with the findings of Otitoju *et al.* (26) but the farm size was lower which indicates that the soybean farmers were averagely small scale producers. The mean age of 48 years indicates that the farmers are still economically active in production of soybean. The mean of the other socioeconomic characteristics indicates that they have low formal education, low access to extension, low access to credit with relatively high household size and also, high farming experience. These characteristics could influence the technical efficiency of the soybean farmers.

Average costs and returns (profitability) of soybean production per hectare

The result in table 2 reveals that fertilizer and labour costs accounted for over 80% of the total variable cost in the three LGAs. The highest soybean yield of 2,110 kg/ha was recorded by the soybean producing households of Shanono LGA, followed by soybean producers of Bunkure LGA (2,012.70 kg/ha) and soybean producers of Dawakin-Tofa (1,984.40 kg/ha). Other factors such as crop management practices may play a part in the soybean yield attained by the LGAs.
Soybean production in the three LGAs was profitable. This result is in line with the findings of Olorunsanya *et al.* (23) who reported that soybean production in Kwara State, Nigeria was profitable. Also, a study conducted by Wilson *et al.* (31) in Chereponi District and Saboba District of northern Ghana revealed that soybean production was profitable in Saboba but not in Chereponi District. Although, soybean production was profitable in the three LGAs, the highest profit (gross margin) and returns per naira invested of N178, 613.22 and 2.5 respectively was earned by the soybean producing households of Dawakin-Tofa LGA. The major factor that accounted for differences in the level of profitability from soybean production in the three LGAs hinges on the ease of access to inputs and output markets. Farmers in Dawakin-Tofa LGA in purchase their inputs (seeds, fertilizers and agro-chemicals) at relatively lower costs in a major regional market known as Dawanau. Also, the sales price of soybean was relatively more attractive in Dawakin-Tofa LGA.
The unit price per kilogram of soybean was highest (N126) in Dawakin-Tofa LGA compared to N117 and N114 unit prices for Shanono and Bunkure LGAs respectively amongst the three LGAs.

Table 1
Summary statistics of variables used in analysis variables.

	Minimum	Maximum	Mean	Standard deviation
Soybean output (kg)	410.24	17453.10	2216.45	1365.21
Seed (kg)	2.3	26.50	7.55	2.36
Land (ha)	0.21	11.25	1.24	5.19
Fertilizer (kg)	0	625.00	210.55	147.20
Labour (man-days)	18.62	145.70	52.25	17.90
Age (years)	23	72	48	12.50
Education (years)	0	29	6	2.11
Household size (household number)	1	33	9	6.38
Farming experience (years)	2	49	16	4.29
Extension (number of contacts)	0	27	4	5.84
Association (years)	0	22	7	4.91
Access to credit (naira)	0	560750.00	25620.65	13022.46

Table 2
Average costs and returns (profitability) of soybean production per hectare.

Item (costs)	Bunkure Amount (N)	Shanono Amount (N)	Dawakin Tofa Amount (N)
Cost of seeds	6, 544.20 (7.6)	5, 156.50 (5.8)	3, 560.45 (5.0)
Cost of labour	38, 567.83 (44.8)	44, 540.01 (49.6)	39, 159.22 (54.8)
Cost of fertilizer	36, 893.55 (42.8)	35, 651.42 (39.8)	25, 300.50 (35.4)
Cost of agrochemicals	4, 100.28 (4.8)	4, 267.40 (4.8)	3, 401.01 (4.8)
Total variable cost (TVC)	86, 105.86	89, 615.33	71, 421.18
Returns			
Yield (kg/ha)	2, 012.70	2, 110.05	1, 984.40
Unit price	114	117	126
Gross income (GI)	229, 447.80	246, 875.85	250, 034.40
GM = GI -TVC	143, 341.94	157, 260.52	178, 613.22
Returns per naira invested (GM/TVC)	1.66	1.75	2.5

NB: Values in parenthesis are percentages of TVC
Official exchange rate at the time of the study: 1US$ = N 198

Table 3
Test of difference of means (ANOVA) of the gross margin of Soybean between the LGAs.

	Sum of squares	Df	Mean square	F value	Sig.
Between Groups	2.46E+10	2	1.56E+10	10.33*	.000
Within groups	1.74E+11	597	1.92E+09		
Total	2.84E+11	599			

NB: *p<0.01

The ANOVA result for testing the mean difference of gross margin of soybean between the three LGAs as shown in Table 3 indicate that there is significant variation in the profitability of soybean between the three LGAs. This implies that although soybean production is profitable in the three LGAs, there is a significant difference in the profitability between the LGAs and Dawakin-Tofa LGA had the highest profitability while Bunkure LGA had the lowest profitability. The results of the profitability test presented in Table 4 shows that in each of the LGAs, profitability of soybean production was significant.
Hence, soybean production in the study area holds a bright future in income generation for farming households, poverty reduction and enhanced food security. This result compares favourably with Biam and Tsue (7) whose result showed that profitability of soybean in Benue, Niger and Plateau States was statistically significant and not due to chance.

Gross margin of soybean production per hectare over different times of the year

A further analysis was undertaken to examine the profitability of soybean across different times of the year because of the seasonal price variation of agricultural products. The result presented in Table 5 revealed that soybean in all the LGAs was more profitable in the third quarter (July to September) of the year, because the unit price of soybean (N153/kilogram) was highest during this period. This is because the period is the peak of the off-season, and demand for soybean is usually higher than the supply during this period. The soybean supply is low as new soybean crops are yet to be harvested. This result implies that soybean farmers who can store their produce until the peak of the off-season stand a better chance of getting more favourable price and generating higher income to improve the well-being of their households. The lowest profitability of soybean was in the fourth quarter (October to December) of the year. This is harvesting period, and farmers who have limited storage capacity often sell immediately after harvest when prices are low (N120/kilogram) due to excess supply in the market.
Most farmers sell their soybean during the harvest season inspite of the lower unit price to meet their household demand for necessities such as food, clothing, shelter, healthcare, education *et cetera*.

Soybean growing households' income from other major crops in the study area

The income earned from soybean production in 2014 was higher than the income earned from established legumes like cowpea and groundnut in all the three LGAs as presented in Table 3. This implies that soybean is a good alternative crop to farming households in the dry savannah of Nigeria because of the huge cash income that the farmers generate from its cropping and the low production cost associated with it.

Table 4

T-test of the profitability of Soybean in each LGA.

LGAs	Total revenue	Total variable cost	Gross margin	Profitability test (t-value)	Sig.
Bunkure	229, 447.80	86, 105.86	143, 341.94	8.82*	.000
Shanono	246, 875.85	89, 615.33	157, 260.52	7.55*	.000
Daw akin-Tofa	250, 034.40	71, 421.18	178, 613.22	12.49*	.000

NB: *p<0.01

Table 5

Gross margin of soybean production per hectare over different times of the year.

Average unit price Amount (N)	Bunkure Amount (N)	Shanono Amount (N)	Daw akin Tofa Amount (N)
First quarter (137)	189, 634.04	199, 461.52	200, 441.62
Second quarter (149)	213, 786.44	224, 782.12	224, 254.42
Third quarter (153)	221, 837.24	233, 222.32	232, 192.02
Fourth quarter (120)	155, 418.14	163, 590.67	166, 706.82

NB: * Average unit price of soybean in the study area over the four quarters of 2015
Source of price data (16)
Official exchange rate at the time of the study: 1US$ = N 198

Table 6

Crop income sources of soybean growing households from other major crops.

Crop income sources	Bunkure Mean(N)	Shanono Mean(N)	Daw akin-Tofa Mean(N)
Income from sale of Soybean	143341.94	157260.52	178613.22
Income from sale of Cow pea	38329.71	42528.78	36624.14
Income from sale of Groundnut	44506.90	50805.84	27302.70
Income from sale of Maize	49114.05	86934.37	59242.42

Table 7
Results of generalized log likelihood-ratio tests of null hypotheses.

LGAs	Null hypothesis	LLF_0	LLF_1	LR statistic	Critical value (5%)	Decision
Bunkure	H_0: $\beta_{ij} = 0$	-503.16	-494.22	17.88	18.31	Accept H_0
Shanono	H_0: $\beta_{ij} = 0$	-642.27	-638.99	6.56	18.31	Accept H_0
Daw akin-Tofa	H_0: $\beta_{ij} = 0$	-294.55	-287.44	14.22	18.31	Accept H_0

NB: H_0: β_{ij} = 0 means the ten second-order parameters are set to 0

Technical efficiency of soybean production in the study area

The results of the generalized likelihood ratio test of null hypotheses (H_0: β_{ij}=0) is presented in Table 7. The calculated likelihood ratio statistic for the estimated models in the LGAs exceeded the chi square value at 5% which indicates that the null hypotheses is accepted and this implies that Cobb-Douglas frontier model produced an adequate representation of the data. Therefore, it is the most preferred model and the discussion of findings will be based on the results of the estimated Cobb-Douglas functional form. This result is not consistent with the findings of Otitoju *et al.* (26) who reported that the translog functional form was preferred over the Cobb-Douglas functional form using data on soybean production in Benue state, Nigeria. This difference in functional form between the two studies could be because the data for the two studies were generated from different farmers, different agroecological zones and different point in time.

The MLE estimates of the parameters of the stochastic frontier Cobb-Douglas production function as presented in Table 8 shows that the estimated sigma squared for soybean farmers in Bunkure (5.09), Shanono (5.39) and Dawakin-Tofa (3.59) were significantly different from zero at 1% level respectively. This indicates a good fit and the correctness of the specified distributional assumption of the composite error terms in the estimated models for the soybean farmers of Bunkure, Shanono and Dawakin-Tofa LGAs respectively. The value of gamma for soybean farmers in Bunkure (0.21), Shanono (0.11) and Dawakin-Tofa (0.69) were all significant at 1% suggesting that 21%, 11% and 68% of the shortfall below the frontier output of the soybean farmers of Bunkure, Shanono and Dawakin-Tofa LGAs respectively was due to the inefficiencies of the farmers.

The estimated coefficients of seed and fertilizer in all the 3 LGAs were in line with a priori expectation as they are positively related with the output of the soybean farmers and this implies that an increase in the use of these inputs will have the tendency of increasing output of soybean production.

This result agrees with that of Okoruwa and Ogundele (22) who reported a positive relationship between seed and output of rice farmers in a study on technical efficiency differentials of rice production technologies in Nigeria. Also, Ogundari *et al.* (19) reported a positive relationship between fertilizer and output levels of farmers.

The estimated coefficients of seeds were significant at 1% and 5% probability levels in Bunkure and Dawakin-Tofa LGAs respectively but not significant in Shanono. The estimated coefficients of fertilizer were not significant in all the LGAs and this could be due to underutilization of this resource, suggesting that the farmers were unable to apply the recommended fertilizer rates for soybean.

Farm size was negatively related with soybean output in all the LGAs and this could be due to overutilization of farm arising from having excess plant population per unit area which is above the recommended plant density for soybean. The implication is that you cannot increase soybean yields in this LGA by increasing farm size without adhering to the recommended plant density for soybean production. However, farm size was only significant in Shanono and Dawakin-Tofa at 5% and 10% probability levels respectively. The estimated coefficient of labour in Bunkure LGA negatively related to output of soybean and was significant at 1% probability suggesting that an increase in the use of labour will have the tendency of reducing output.

This implies that to maintain the cost of production at the limit of their lean resources when additional hired labour is to be consumed, the resource-poor soybean farmers must cut down the level of their production. This finding is in line with Asogwa *et al.* (4) that 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. In Shanono and Dawakin-Tofa LGAs, the estimated coefficients of labour were positively related to output of labour as expected but were not significant. The result of the determinants of inefficiency from the estimated inefficiency model is reported in Table 8. A negative sign on a parameter means that the variable reduces technical inefficiency (therefore increases technical efficiency), while a positive sign increases technical inefficiency. The results showed that the estimated coefficients of age of farmers, marital status, and education have negative signs

Table 8

Technical efficiency of soybean producing households based on Cobb-douglas function.

Variables	Parameters	Bunkure LGA Coeff.	Bunkure LGA T value	Shanono LGA Coeff.	Shanono LGA T value	Dawakin-Tofa LGA Coeff.	Dawakin-Tofa LGA T value
Constant	β_0	6.52	6.82***	5.52	5.63***	4.30	4.20***
Farm size (X_1)	β_1	-0.33	-1.36	-1.96	-2.57**	-0.54	-1.70*
Seed (X_2)	β_2	0.78	3.91***	0.64	0.66	0.73	2.14**
Fertilizer (X_3)	β_3	0.08	0.63	2.02	6.62***	0.10	0.68
Labour (X_4)	β_4	-8.25	-4.50***	0.10	0.13	0.31	1.25
Inefficiency model							
Constant	α_0	0.01	0.01	-3.79	-3.82***	0.01	66.58***
Age of farmer (Z_1)	α_1	-0.02	-0.69	0.02	0.35	0.25	1.35
Marital status (Z_2)	α_2	-1.89	-4.15***	-0.01	-0.01	0.01	0.01
Education (Z_3)	α_3	-0.01	-0.07	-0.02	-0.19	-0.05	-0.15
Household size (Z_4)	α_4	0.09	1.73*	-0.64	-8.75***	0.05	0.42
Farming experience (Z_5)	α_5	0.02	0.76	-0.07	-2.28**	-0.24	-3.19***
Extension contact (Z_6)	α_6	0.10	0.61	0.06	0.63	-0.73	-1.70*
Association (Z_7)	α_7	1.18	2.50**	-0.01	-0.01	-0.06	-0.07
Access to credit (Z_8)	α_8	0.00	1.44	-0.00	-7.75***	0.00	1.20
Variance parameters							
Sigma squared	σ^2	5.09	8.01***	5.35	5.59***	3.79	3.91***
Gamma	Γ	0.21	13.22***	0.11	5.59***	0.68	8.51***
Log likelihood function		-503.16		-642.27		-294.55	
Mean Technical Efficiency	*TE*	0.68		0.59		0.87	

NB: ***p<0.01; **p<0.05; *p<0.10.

among the soybean producing households in Bunkure LGA implying that they have the tendency of reducing their technical inefficiency (or increase technical efficiency) of soybean production. However, it was only marital status that was significant at 1% probability level. In Shanono LGA, the estimated coefficients of marital status, education, household size, farming experience, membership of association and access to credit were all negative indicating that they all reduce inefficiency in soybean production. However, only household size, farming experience and access to credit were significant at 1%, 5% and 1% probability levels respectively.

An increase in household size could inject more farm labor thereby reducing the cost of hired labour incurred and stimulate more soybean production. This finding agrees with that of Ahmadu and Erhabor (1) who reported that family size was negative and significantly related to the technical inefficiency of rice farmers in Taraba State, Nigeria. An increase in farming experience of the soybean farmers decreases their technical inefficiency as a result of the management skills they acquired over time. This finding compares favourably with that of Asogwa et al. (4) who reported that farming experience was negative and significantly influenced the output of farmers. Increase in the farmers access to credit have the tendency of reducing their technical inefficiency as credit affords them the opportunity of ensuring timely purchase of inputs for soybean production and access improved technologies for soybean production in the LGA. This finding agrees with Ogundari et al. (19) that found access to credit was negative and significantly influenced the technical inefficiency of rainfed rice farmers in Ondo State, Nigeria. In Dawakin-Tofa LGA, the estimated coefficients of education, farming experience, extension contacts and membership of association were all negative suggesting that they reduced inefficiency in soybean production. Only extension contact and farming experience were significant at 10% and 1% probability levels respectively.

Technical efficiency scores of the soybean growing households in the study area

The results in Table 10 showed that the mean technical efficiency was highest for Dawakin-Tofa LGA soybean growing households (87%), followed by Bunkure LGA soybean growing households (68%), and Shanono LGA soybean growing households (59%). In comparison with a similar study conducted in northern Ghana by Etwire *et al.* (13), the mean technical efficiency estimate of the soybean farmers in Dawakin-Tofa, Bunkure and Shanono were higher than the mean technical efficiency of 53% obtained in northern Ghana. Soybean growers in Dawakin-Tofa were more technically efficient than the soybean growers in the other two LGAs as they managed their production inputs (seed, fertilizer, labour and farm

Table 9
Technical efficiency of soybean producing households based on translog function.

		Bunkure LGA		Shanono LGA		Dawakin-Tofa LGA	
Variables	Parameters	Coeff.	T value	Coeff.	T value	Coeff.	T value
Constant	β_0	3.11	2.94***	2.75	1.93*	6.58	3.01***
Farm size (X_1)	β_1	0.92	2.36***	-0.55	-1.33	-1.21	-1.68*
Seed (X_2)	β_2	1.22	2.02**	0.85	1.59	1.35	1.60
Fertilizer (X_3)	β_3	-1.13	-1.42	0.65	2.21**	-0.32	-1.70*
Labour (X_4)	β_4	-0.50	-0.91	1.33	3.01***	1.41	0.95
½(Farm size)^2	β_{11}	0.64	0.88	0.59	2.67***	0.78	0.92
½(Seed)^2	β_{22}	-0.51	0.78	0.37	0.81	0.62	1.95
½(Fertilizer)^2	β_{33}	1.28	2.84***	-0.21	-1.54	0.77	1.02
½(Labour)^2	β_{44}	-1.06	-0.71	1.31	0.88	-1.33	-1.60
[(Farm size)x(Seed)]^2	β_{12}	0.56	1.32	0.91	5.41***	-0,08	-1.12
[(Farm size)x(Fertilizer)]^2	β_{13}	1.59	0.11	0.09	1.55	1.02	3.89***
[(Farm size)x(Labour)]^2	β_{14}	-0.84	-1.99**	0.31	2.56***	0.46	0.87
[(Seed)x(Fertilizer)]^2	β_{23}	0.05	1.61	-0.45	-0.71	-0.05	-1.33
[(Seed)x(Labour)]^2	β_{24}	1.44	0.58	1.35	0.23	-0.53	-1.95*
[(Fertilizer)x(Labour)]^2	β_{34}	-0.78	-4.32***	0.06	1.19	0.85	1.38
Inefficiency model							
Constant	α_0	2.11	5.22***	1.25	2.64***	4.21	3.01***
Age of farmer (Z_1)	α_1	0.33	2.88***	-0.19	-1.59	0.66	1.94*
Marital status (Z_2)	α_2	0.05	1.09	-0.17	-1.68*	-1.28	2.61***
Education (Z_3)	α_3	-0.07	-2.95***	-1.10	-1.53	0.51	1.23
Household size (Z_4)	α_4	-0.33	1.56	-1.29	-0.67	0.25	0.88
Farming experience (Z_5)	α_5	-1.44	-1.80*	-0.15	-1.50	-0.91	-5.03***
Extension contact (Z_6)	α_6	-0.89	-1.07	-0.73	-1.37	1.01	0.84
Association(Z_7)	α_7	0.93	1.38	-1.22	-4.16***	-1.25	-1.33
Access to credit (Z_8)	α_8	0.09	1.50	-0.02	-1.68*	-0.34	-1.02
Variance parameters							
Sigma squared	σ^2	1.21	3.22***	2.08	1.93*	1.71	2.41***
Gamma	Γ	0.48	4.51***	0.09	2.01**	0.22	4.19***
Log likelihood function		-494.22		-638.99		-287.44	
Mean Technical Efficiency	*TE*	0.68		0.87		0.59	

NB: ***p<0.01; **p<0.05; *p<0.10.

Table 10
Technical efficiency scores for soybean producing households.

Estimate	Bunkure (%)	Shanono (%)	Dawakin-Tofa (%)
Maximum	98	92	97
Minimum	10	36	10
Mean	68	59	87

size) better than the soybean farmers in Bunkure and Shanono LGAs. However, all the soybean producing households were yet to attain 100% frontier output as 13%, 32% and 41% of potential soybean yields were lost respectively in Dawakin-Tofa, Bunkure and Shanono LGAs due to inefficiency in soybean production. This result implies that given the current level of resources available to the soybean producing households, they can enhance their soybean output in the short run by a margin of 13%, 32% and 41% in Dawakin-Tofa, Bunkure and Shanono LGAs respectively through efficient utilization of their available resources.

This requires that the soybean farmers will ensure that they utilize the recommended soybean production practices they are exposed to via extension activities. As noted by Bifarin *et al.* (8), public investment geared to improve the provision of managerial support and dissemination of information to smallholder farmers via extension programs, or other forms of non-formal education, are likely to lead to higher levels of efficiency. The minimum and maximum technical efficiencies estimates for the soybean growing households were 10-98%, 36-92% and 10-97% in Bunkure, Shanono, and Dawakin Tofa LGAs respectively.This means the most technically efficient farmer was amongst the Bunkure LGA soybean growing households (98% technical efficiency score), while the least efficient soybean producing households were in Bunkure and Dawakin-Tofa LGAs (10% technical efficiency scores).

Conclusion

This study has established that soybean production is profitable in the dry savannah of northern Nigeria despite the high cost of fertilizer and labour inputs and also, the profitability of soybean varied across the three LGAs of the study area. Considering the high cost of fertilizer and labour inputs in soybean production, any intervention that will reduce fertilizer and labour costs may increase the profitability of soybean in the study area.

Findings from the technical efficiency estimation indicated that all the soybean producing households were yet to attain frontier output (100%), as 13%, 32% and 41% of potential soybean yields were lost respectively in Dawakin-Tofa, Bunkure and Shanono LGAs due to inefficiency in soybean production. The policy implication of the study is that technical efficiency in soybean production could be increased by 13, 32 and 41% respectively in Dawakin-Tofa, Bunkure and Shanono LGAs through improved use of available resources, given the current state of technology. This can be achieved through improved farmer-specific efficiency factors, which include access to credit for farmers in Shanono LGA, education for farmers in Bunkare LGA and extension contact, access to credit for farmers in Dawakin Tofa LGA.

Based on the findings of the study, it is recommended that the soybean farmers through extension agents should be encouraged to adhere strictly to the recommended soybean production practices towards ensuring efficient utilization of their available resources so that they can improve their technical efficiency, profit generation and the welfare of their households.

Acknowledgements

This paper is based on research that was conducted as part of promoting soybean for income and food security in the dry savannah of northern Nigeria, Kano State. The authors acknowledged the Alliance for Green Revolution in Africa (AGRA) for funding the project, and International Institute of Tropical Agriculture (IITA), Nigeria for providing the improved early maturing soybean varieties for dissemination to farmers.

Literature

1. Ahmadu J. & Erhabor P.O., 2012, Determinants of Technical Efficiency of Rice Farmers in Taraba State, Nigeria, Niger, *J. Agric. Food Env.*, **8**, 3,78-84.
2. Alimi T. & Manyong V.M., 2000, *"Partial Budget Analysis for On-Farm Research*". Research Guide No. 65. International Institute of Tropical Agriculture, Ibadan, Nigeria.
3. Amaza P.S., Bila Y. & Iheanacho A.C., 2006, Identification of Factors that Influence Technical Efficiency of Food Crop Production in West: Empirical Evidence from Borno State, Nigeria*, J. Agric. Rural Dev. Trop. Subtrop.*, **7**, 2, 139-147.
4. Asogwa B.C., Umeh J.C. & Penda S.T., 2011, Analysis of Economic Efficiency of Nigerian Small Scale Farmers: A Parametric Frontier Approach, *J. Econ*., **2**, 2, 89-98.
5. Aye G.C. & Mungatana E.D., 2000, Technical Efficiency of Traditional and Hybrid Maize Farmers in Nigeria: Comparison of Alternative Approaches, *Afr. J. Agric. Res*., **5**, 21, 2909-2917.
6. Battese G.E. & Coelli T.J., 1992, Frontier Production Functions, Technical Efficiency and Panel data: with Application to Paddy Farmers in India*, J. Prod. Anal*., **3**, 1-2, 153-169.

7. Biam C.K. & Tsue, P.T., 2013, Profitability of Soyabean Production by Small Holder Farmers inNigeria: A Guide for Sustainable Food Security*, Eur. J. Bus. Manage*., **5**, 30, 89 -96.
8. Bifarin J.O., Alimi T., Baruwa O.I., & Ajewole O.C., 2010, *Determinant of Technical, Allocative and Economic Efficiencies in the Plantain* (Musa spp.) *Production Industry, Ondo State, Nigeria*. In: *Proceeding of International Conference on Banana & Plantain in Africa*, 199-210.
9. Bozoglu M., & Ceyhan V., 2007, Measuring Technical Efficiency and Exploring the Inefficiency Determinants of Vegetable Farms in Samsun Province, Turkey, *J. Agric. Syst.*, **94**, 3, 649 - 556.
10. Brader L., 1998, *IITA's Benchmark Approach to Natural Resource Management in West and Central Africa.* Paper Presented during International Centres' Week, Washington DC, 31 USA. 26-30th October, 1998.
11. Dashiell K.E., Bello L.L., & Root W.R., 1987, *Breeding Soybeans for the Tropics, Pages 3-16 in Soybean for the Tropics. Research, Production and Utilisation*, Edited by S. R. Singh, K.O. Rachie, and K. E. Dashiell. John Wiley and Sons Ltd., Chichester, UK.
12. Edema M.O., Sanni O, & Sanni A.I., 2005, Evaluation of Maize-Soybean Flour Blends for Sour Maize Bread Production in Nigeria, *Afr. j. Biotechnol*., **4**, 911-918.
13. Etwire P.M., Martey E. & Dogbe W., 2013, Technical Efficiency of Soybean Farms and Its Determinants in Saboba and Chereponi Districts of Northern Ghana: A Stochastic Frontier Approach, *Sust. Agric. Res*., **4**, 2, 106 – 116.
14. Farrel J.M., 1957, The Measurement of Productive Efficiency, *J. R. Stat.*, **120,** 3, 253-290.
15. Greene W.H., 1993, *Frontier Production Function. EC-93-20*. Stern School of Business, New York University.
16. Lissitsa A., & Odening M., 2005, Efficiency and Total Factor Productivity in Ukrainian Agriculture in Transition, Agricultural Economics, *J. Int. Assoc. Agric. Econ*., **32**, 3, 40-56.
17. Kumbhaker S.C., & Lovell C.A.K., 2000, *Stochastic Frontier Analysis, Cambridge*, Cambridge University Press. 18.
18. National Agricultural Extension and Research Liaison Services (NAERLS)., 2015, *Average Prices of Selected Agricultural Commodities in Nigeria*.
19. Ogundari K., Ojo S.O., & Ajibefun I.A., 2006, Economics of Scale and Cost Efficiency in Small Scale Maize Production, Empirical Evidence from Nigeria, *J. Social Sci.*, **13**, 2,131-136.
20. Ojiako I.A., 2006, *Economic Evaluation of Adoption of Improved Soybean Production and Utilization Technologies in Kaduna and Kano States, Nigeria.* PhD Thesis, Department of Agricultural Economics, University of Ibadan, Nigeria.
21. Okogun J.A., Sanginga N., Abaidoo R., Dashiell K.E., & Diels J., 2005, On-Farm Evaluation of Biological Nitrogen Fixation Potential and Grain Yield of Lablab and Two Soybean Varieties in the northern Guinea Savanna of Nigeria, *Nutr. Cycl. Agrosyst.*, **73**, 267-275.
22. Okoruwa V.O., & Ogundele O.O., 2006, *Technical Efficiency Differentials in Rice Production Technologies in Nigeria*, www.csae.ox.ac.uk/conference/2006-EO-RPI/papers/csae/okoruwa.pdf, 8th August, 2014.
23. Olorunsanya E.O., Babatunde R.O., Orebiyi J.S., & Omotosho J.O., 2009, Economic Analysis of Soybean Production in Kwara State, north central Nigeria, *Global Approaches to Extension Practice* (GAEP), **5**, 2, 45 – 53.
24. Olukosi J.O. & Erhabor P.A., 1998, *Introduction to Farm Management Economics; Principles and Applications*, Agitab publishers Ltd, Zaria-Nigeria: 71-85.
25. Otitoju M.A. & Arene C.J., 2010, Constraints and Determinants of Technical Efficiency in Medium-Scale Soybean Production in Benue State, Nigeria, *J. Agric. Res.*, **5** 17, 2276-2280.
26. Otitoju M.A., Adebo, G.M. & Arene C.J., 2014, Identification and Stochastic Analysis of Factors Influencing Technical Inefficiency of Nigerian Smallholder Soybean Farmers, *Tropicultura*, **32**, 4, 197-204.
27. Sanginga N., Okogun J., Vanlauwe B. & Dashiel K., 2002, The Contribution of Nitrogen by Promiscuous Soybean to Maize-Based Cropping in the Moist Savanna of Nigeria, *Plant Soil*, **242**, 223-231.
28. Sanginga P.C., Adesina A.A., Manyong V.M., Otite O., & Dashiel K.E., 2002, *Social Impact of Soybean in Nigeria's southern Guinea Savanna*, IITA, Ibadan, Nigeria: 1-32.
29. Shannon D. A. & Mwamba K.M., 1994, Adoption of Soybean in Sub-Saharan Africa: A Comparative Analysis of Production and Utilization in Zaire and Nigeria, *Agric. Syst.*, **46**, 369-384.
30. Shapiro K.H., 1983, Efficiency Differentials in Peasant Agriculture and their Implications for Development Policies, *J. Dev. Stud*., **19**, 2, 77 – 190.
31. Wilson D., Etwire P.M., Martey E., Etwire J.C., Baba I.I.Y., & Siise A., 2013, Economics of Soybean Production, Evidence from Saboba and Chereponi Districts of Northern Region of Ghana, *J. Agric. Sci.*, **5**, 12, 28 – 46.
32. Yegon P.K., Kibet L.K. & Lagat J.K., 2015, Determinants of Technical Efficiency in Smallholder Soybean Production in Bomet District, Kenya, *J. Dev. Agric. Econ*., **7**, 5,190-194.

O.O. Ugbabe, Nigerian, PhD, Ahmadu Bello University, Institute for Agricultural Research, Zaria, Nigeria.

T. Abdoulaye, Nigerien, PhD, International Institute of Tropical Agriculture, Ibadan, Nigeria.

A.Y. Kamara, Sierra Leonean, PhD, International Institute of Tropical Agriculture, Ibadan, Nigeria.

O. Oyinbo, Nigerian, M.Sc, Institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria.

J. Mbavai, Sierra Leonean, M.ED, Bayero University, Faculty of Education, Department of Community Development, Kano, Nigeria.