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Allocative Efficiency of Groundnut (*Arachis hypogea* L.)-Based Cropping Systems in Taraba State, Nigeria

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ABSTRACT

Despite numerous efforts by the Nigerian government to revitalize the production of groundnut through research, crop improvement practices and vast resources of land, there seems to be inadequate supply of groundnuts to meet both the local and international market demand. The study examined the allocative efficiency of groundnut-based cropping systems in Taraba State, Nigeria. Primary data were collected from 354 groundnut-based farmers using purposive and random sampling techniques using questionnaires which were administered to groundnut producers in the study area. The data collected were analysed using stochastic cost function. The Maximum Likelihood Estimates (MLE) of the stochastic cost function for groundnut-based cropping systems, namely; sole groundnut, groundnut/maize, groundnut/cowpea, groundnut/sorghum/cowpea,groundnut/sorghum, groundnut/millet and groundnut/cassava show mean allocative efficiencies of 77%, 89%, 83%, 91%, 92%, 91% and 94% respectively. The elasticity of output with respect to cost of labour, cost of groundnut seed, cost of fertilizer, cost of land, cost of transportation and cost of agro-chemicals were positive and statistically significant at both 1% and 5% levels in most of the enterprises. The estimated coefficient of the cost inefficiency model revealed that membership of association, age, household size, educational level, extension visit and farming experience were the dominant sources of allocative inefficiency among the groundnut-based farmers in most of the enterprises. The study recommends that farmers should form co-operative groups in order to address high cost of labour, inadequate access to credit facilities and high cost of agro-chemical. This will help to mobilize savings and improve farmers' efficiencies.

INTRODUCTION

Agriculture remains a vital sector in Nigeria's economy, accounting about 23% of GDP and employing over 70% of the labor force (World Bank, 2023). Among the various crops cultivated, groundnut (Arachis hypogea L.) holds significant economic and nutritional importance, particularly in the northern regions where it serves as both a cash crop and a staple food. Historically, Nigeria was a leading global exporter of groundnuts in the 1960s, but production declined due to factors such as pest infestations, drought, and policy neglect (Abdullahi et al., 2022). In current years, efforts by the government and international organizations, including the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), have determined on reviving the sector through improved seed varieties and sustainable farming practices (ICRISAT, 2023). However, despite these interventions, smallholder farmers continue to face challenges such as low productivity, inefficient resource allocation, and unstable market conditions (Oyinbo et al., 2023).

Groundnut production in Nigeria is concentrated in the northern states, including Kano, Kaduna, Jigawa, and Katsina, where it stages a crucial responsibility in livelihoods and food security (NAERLS, 2022). The country is currently the third-largest producer of groundnuts in Africa, with an annual output of approximately 3.1 million metric tons (FAOSTAT, 2023). However, yields remain low, averaging 1.2–1.5 tons per hectare, compared to the global average of 2.5 tons per hectare (USDA, 2023). This productivity gap is attributed to several factors, including poor access to quality inputs, climate variability, and inadequate adoption of modern farming techniques. For instance, many farmers underutilize fertilizers and improved seeds as a result of high costs and inadequate availability (Ojo et al., 2023). Additionally, climate change has exacerbated production challenges, with erratic rainfall and rising temperatures negatively affecting crop performance (IPCC, 2022).

Efficiency is the ability to produce a given level of output at the lowest cost (Farrell, 1957). The concept of efficiency has three components: technical, allocative and profit (economic). Technical efficiency is the ability of a firm to achieve a higher level of output given similar levels of inputs. Allocative efficiency deals with the extent to which farmers make efficient decisions by using inputs up to the level at which their marginal contribution to production value is equal to the factor costs. The production of a given output is, therefore, profit efficient when the producer combines resources in the least combination to generate maximum output as well as ensuring least cost to obtain maximum profits. Technical and allocative efficiencies are components of profit efficiency. In the context of groundnut farming, achieving allocative efficiency involves selecting the right combination of inputs and cropping systems, whether sole cropping, intercropping, or rotation with other crops like maize or cowpea. Studies have shown that intercropping groundnut with cereals can enhance resource use efficiency and improve soil fertility (Kamara et al., 2023). However, many Nigerian farmers still rely on traditional methods, leading to suboptimal productivity and income (Oluwasusi&Akanni, 2023). Addressing these inefficiencies is essential for boosting agricultural productivity and ensuring food security.

The persistent inefficiencies in groundnut production systems underscore the need for this study as indicated by researchers (Abubakari, et al., 2019; Aboki, *et al*., 2018; Biye, et al., 2018; Taphee, *et al*., 2015; Taphee and Jongur, 2014) . Many farmers operate below their potential due to poor input allocation, limited access to credit, and weak market linkages. For example, while labor is often overused, fertilizers and improved seeds are underutilized, resulting in lower yields (Abdulrahman & Muhammad-Lawal, 2022). Furthermore, inadequate extension services and policy support have hindered the adoption of best practices. By evaluating the allocative efficiency of different groundnut cropping systems, this paper aims to identify the main constraints upsetting productivity and propose actionable recommendations. The findings will contribute to Nigeria's Agricultural Transformation Agenda (ATA) and the National Agricultural Technology and Innovation Policy (NATIP), which seek to enhance food security and farmer incomes (FMARD, 2023). Ultimately, improving allocative efficiency in groundnut farming can lead to increased yields, better resource management, and higher profitability for smallholder farmers. This study concentrated on allocative efficiency of groundnut-based cropping systems in Taraba State. However, the explicit objectives were to estimate the level of allocative efficiency as well as the allocative inefficiency of groundnut-based cropping systems in Taraba State.

METHODOLOGY

The Study Area

This study was conducted in Taraba State which is one of the 36 states in Nigeria. The state is situated at the north eastern part of Nigeria. It lies between latitude 6°30' and 8° 30' north of the equator and between longitude 9° 00' and 12° 00' east of the Greenwich meridian (Oruonye, 2014). The state has boundaries with Bauchi and Gombe States in the north, Adamawa State in the east, and the Cameroon Republic in the south. The state is bordered along its western side by Plateau, Nassarawa and Benue States. The state has a land mass of 60,291km^2 with a population of about 2,300,736 in 2006 and the present projected population of 2020 is 3,331,440 (NBS 2023; NPC, 2020). The state is alienated into sixteen Local Government Areas (LGAs) and three senatorial districts (Taraba north, central and south). Taraba State is considered as Nature's Gift to the Nation due to its rich natural resources endowment (Oruonye, 2014). The main livelihood of the people of Taraba State is agriculture. The state has a tropical climate manifested by dry and rainy seasons.

Sources and Methods of Data Collection

The study used primary data which were collected with the help of questionnaire administered to groundnut producers in the study area.

Sampling Techniques

Purposive sampling method and simple random sampling procedure were employed to select the Local Government Areas and the respondents for the study. Firstly, two (2) Local Government Areas from the three agricultural zones in the State (1, 2 and 3) were selected purposively making a total of six (6) Local Government Areas used for the study based on the high involvement in groundnut production. The second stage involved the purposive choice of two (2) wards from each Local Government Area making a total of 12 wards. The third stage involved the choice of villages and respondents from each ward using simple random technique making a total of 50 villages and 360 respondents but only 354 questionnaires were returned with useful information. The random selection of the 50 villages and 360 respondents from the zones was based on a proportionality factor. It is expressed as follows table 1:

$$S = \frac{X}{Y} * \frac{Q}{1} \quad \text{---} \quad (1)$$

where
S = Total number of villages sampled.
X =Number of villages in each ward.
Y = Total population of villages
Q = Total number of villages in each political zone.

Table1: Selected Local Government Areas, Wards and Villages in Taraba State

Zones	LG	Wards	Total No. of Villges	No. of selected Villges	Names of Selected Villages	Pop. Of the Villages	No. of Selected Respondents
Zone I	Yorro	Sumbu 1	9	3	Pantinapu	121	9
					Lankaviri	92	7
					PantiBasheng	84	6
		Pupule 2	7	2	Narapo	78	6
					LayangWerebang	71	5
	Zing	Yakoko	18	6	Kozang	67	5
					Della	73	6
					Butuga	126	10
					Bisomporong	110	8
					Lankan	72	5
					Kwenzang	115	9
		Lamma	13	5	Lamma 1	91	7

					Dongkwanti	76	6
					Dendi	138	10
					Koyu	124	9
					Bansi	72	5
Zone II	Bali	Kaigama	17	6	Kankani	85	6
					J/Budowa	78	6
					J/Nabayi	56	4
					B/Wurkum	108	8
					Maibultu	86	6
					Sandaru	91	7
		Suntai	20	7	Jatau	101	8
					Maigogo	181	14
					Kwassa	152	11
					K/Damisa	58	4
					Kungana	87	7
					Gobir	96	7
					M/Joji	73	6
Zone III	Gashaka	Gangumi	11	4	Kare	53	4
					Karin Tiv	77	6
					Afengi	89	7
					Ganti	111	8
		Jamtari	8	3	Koti	98	7
					Karamti	121	9
					Nyibango	105	8
	Takum	Manya	6	2	Gangum	98	7
					Tati Kumbo	90	7
		Dutse	20	7	Fanwe	60	5
					Basang	81	6
					Gindi Dutse	78	6
					Muji	63	5
					Tampa	147	11
					Mbiya	132	10
					Tanyi	52	4
	Ussa	Kwesati	6	2	Tutuwa	195	15
					Kusansang	87	7
		Kpambo	8	3	K/Ukwai	93	7
					Riyin Kabrisi	82	6
					K/Yrom	98	8
	Total		143	50		4772	360

Methods of Data Analysis

Stochastic Frontier Cost Function

This was used in estimating the allocative efficiency of groundnut-based farmers.

The model is specified as:

$C_i = g(P_{ij}\beta_{ij}) + (V_{ij}-U_{ij})$ -- (2)

Where:
C_i = Total production cost of i^{th} farmer
P_i = Vector of variable input prices used by the i^{th} farmer
g = Suitable functional form such as Cobb-Douglas function
β = Parameters to be estimated
V_i = Symmetric component which represents random disturbance cost due to factors outside the control of the farmers.
U_i = One sided disturbance term used to represent allocation inefficiency
U_i is independent of V_i. The cost efficiency of individual farmer is defined in term of the ratio of observed cost (C^0) to the corresponding minimum cost (C^m) given the available technology.

$$\text{Cost efficiency } (C_E) = \frac{C^0}{C^m} = \frac{g(P_i,\beta)+V_i - U_i}{g(P_i,\beta)} = \exp(U_i) \text{--} \quad (3)$$

Where
C^0 = the observed cost and represents the actual total production cost
C^m = the minimum cost and represent the frontier total production cost or least total production level
The explicit Cobb Douglas functional form for groundnut-based farmers is specified as follows;

$$LnC = \alpha_0+\alpha_1 InP_1+\alpha_2 InP_2+\alpha_3 InP_3+\alpha_4 InP_4+\alpha_5 InP_5+\alpha_6 InP_6 + (Vi-U_i) \text{ -----------------------} \quad (4)$$

Ln = Logarithm to base e
C_1 = Total production cost of the ith farm (naira/ha)
P_1 = Cost of land (naira/ha)
P_2 = Cost of groundnut seed planted (naira/ha)
P_3 = Cost of transportation (naira/ha)
P_4 = Cost of labour (naira/ha)
P_5 = Cost of agrochemicals used (naira/ha)
P_6 = Cost of fertilizer used (naira/ha)

The cost inefficiency effect (U_i) is independently distributed and arises by truncation at zero of the normal distribution where U_i model is defined by:

$$\mu_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

Where;
μ_i = The cost inefficiency of the i^{th} farm;
Z_1 = Age of farmers.
Z_2 = Formal education (years spent in school),
Z_3 = Years of farming experience,
Z_4 = Credit availability (access = 1, no access =0)
Z_5 = Extension contact (Yes = 1, No = 0),
Z_6 = Household size (number of persons in a household).
Z_7 = Membership of association (Yes =1, No = 0).
δ = Vector of unknown parameter to be estimated

RESULTS AND DISCUSSION

Allocative Efficiency in Groundnut-Based Cropping Systems

Allocative Efficiency for Sole Groundnut Enterprise

The maximum likelihood estimate for the parameters of the stochastic frontier cost model of sole groundnut farmers is presented in Table 1. It contained the estimates of the parameters for the frontier cost model, the inefficiency model and the variance parameter model. The estimated sigma squared was 0.016 and was statistically significant at 1% probability level. It indicates a good fit and correctness of the distributional form assumed for the composite error term. The gamma estimates was 0.735 and statistically significant at 5% probability level. This means that about 74% of the variation in the total cost of production among the farmers was due to differences in allocative efficiency.

The estimated total cost of land was 0.015 and statistically significant at 10% probability level. The estimated coefficient of the cost of transportation was 0.023 and statistically significant at 5% probability level. This means that a 1% increase in transportation cost would lead to 0.023% add to in the total cost of production, but high transportation cost, affects a lot of farmers negatively. Cost of labour has positive coefficient of 0.041 and statistically significant at 1% probability level. It shows that for every 1% increase in the cost of labour, there would be 0.041% increase in the total production cost. The estimated coefficient of the fertilizer was 0.021 and statistically significant at 10% probability level. It indicates that a 1% increase in the fertilizer cost would lead to 0.021% increase in the total production cost. It reveals that these factors had direct correlation with the total production cost of sole groundnut enterprise.

Allocative Efficiency Indices of Sole Groundnut Enterprise

The allocative efficiency indices derived from the stochastic frontier cost function is presented in Table 3. The result revealed the minimum and maximum farmers' allocative efficiency of 0.59 and 0.96 respectively. This showed that there was a wide variation between the least allocative efficient farmers and the best allocative efficient farmers. The least allocative efficient farmer would require just 41% (i.e 1.00-0.59) to achieve allocative efficient gain while the best allocatively efficient farmer would require just 4%(i.e. 1.00- 0.96) to attain maximum allocative efficiency level. The mean allocative efficiency was 0.77. The allocative efficiencies of all the farmers was is not up to 1.00, which implies that all the sole groundnut farmers were operating below maximum cost frontier. An average farmer in the short run under existing technology could increase allocative efficiency by 23% through better utilization of resources in optimal proportions given their respective prices. This finding is similar to the one obtained by Abdullahi (2015) who obtained a mean allocative efficiency of 0.89.

Allocative Efficiency for Groundnut/Maize Enterprise

The stochastic frontier cost function of groundnut/maize farmers is presented in Table 1. This contains frontier cost function, inefficiency model and the variance parameter model. The estimated sigma squared was 0.039 and was statistically significant at 5% probability level. It shows a good fit and correctness of the distributional form assumed for the composite error term. The gamma estimates was 0.665 and statistically significant at 1% probability level. This means that 67% in variation of the total production cost among the sampled respondents was because of the differences in cost efficiency.

The estimated coefficient in cost of groundnut seed was 0.021 and statistically significant at 10% probability level. It shows that a 1% increase of the cost of planting materials would lead to 0.021% increase in the total production cost. The estimated coefficient of the cost of transportation was 0.050 and statistically significant at 5% probability level. Cost of labour has positive coefficient of 0.039 and statistically significant at 1% probability level. The estimated coefficient of cost of agro-chemicals was 0.045 and statistically significant at 1% probability level showing that a 1% increase in the cost of agro-chemical would lead to 0.045% increase in total production cost. Umaru (2016) also found out that increase in agro-chemical cost will lead to total cost of production. The estimated coefficient in the fertilizer cost was 0.024 and statistically significant at 10% probability level, indicates that a 1% increase in the cost of fertilizer would lead to 0.024% increase in the total production cost.

Table1: Maximum Likelihood Estimates of the Stochastic Frontier Cost function for Sole Groundnut, Groundnut/Maize, Groundnut/Cassava and Groundnut/Sorghum/cowpea Farmers.

		Sole Groundnut			**Groundnut/Maize**			**Groundnut/Cassava**			**Groundnut/Sorghum/cowpea**		
Variable	Parameter	Coefficient	Standard Error	t-ratio	Coefficient	Standard Error	t-ratio	Coefficient	Standard Error	t-ratio	Coefficient	Standard Error	t-ratio
Cost Factors													
Constant	β_0	4.550***	0.151	30.207	4.341***	0.134	32.219	4.306***	0.218	19.722	1.396***	0.185	7.562
Land	β_1	0.015*	0.009	1.632	0.016	0.011	1.491	0.016	0.017	0.956	0.019**	0.007	2.756
Groundnut seed	β_2	0.025	0.017	1.479	0.021*	0.012	1.754	0.034**	0.016	2.095	0.032***	0.008	4.288
Transportation	β_3	0.023**	0.008	2.930	0.050**	0.018	2.802	0.095	0.130	0.735	0.071*	0.043	1.680
Labour	β_4	0.041***	0.010	3.943	0.039***	0.012	3.314	0.056***	0.012	4.881	0.642**	0.263	2.441
Agro-chemical	β_5	0.073	0.109	0.665	0.045**	0.022	2.053	0.071**	0.028	2.505	0.103***	0.027	3.798
Fertilizer	β_6	0.021*	0.012	1.704	0.024*	0.148	1.610	0.027	0.017	1.582	0.081	0.053	1.520
Inefficiency Effects													
Constant	δ_0	-0.600	0.456	-1.316	-0.885	1.781	-0.497	-3.735	2.722	-1.372	-7.372***	0.936	-7.877
Age	δ_1	-0.401***	0.128	-3.133	-0.122	0.077	-1.597	-0.208***	0.064	-3.270	-0.386***	0.059	-6.526
Education	δ_2	-0.015	0.022	-0.672	-0.130**	0.053	-2.459	-0.090**	0.034	-2.645	-0.401***	0.036	-11.73
Farming experience	δ_3	-0.203**	0.082	-2.488	-0.386***	0.125	-3.095	-0.119	0.087	-1.366	-5.314***	1.641	-3.238
Credit availability	δ_4	-0.029	0.035	-0.838	-0.379	0.250	-1.517	-0.237	0.168	-1.408	-0.079	0.087	-0.917
Extension agent contact	δ_5	-0.086***	0.028	-3.090	-0.111	0.122	-0.912	-0.178	0.146	-1.219	-0.121*	0.067	-1.793
Household size	δ_6	0.074	0.143	0.514	-0.149**	0.057	-2.632	-0.604**	0.218	-2.775	0.570	0.382	1.493
Membership of association	δ_7	-0.108**	0.051	-2.134	-0.045	0.112	-0.399	-0.686***	0.222	-3.094	-0.646***	0.066	-9.797
Diagnostic Statistics													
Sigma squared	δ^2	0.016***	0.004	4.181	0.039**	0.017	2.364	0.050**	0.021	2.390	0.308***	0.050	6.140
Gamma	γ	0.735**	0.314	2.342	0.665***	0.187	3.560	0.858***	0.237	3.616	0.798***	0.181	4.403

*Source: Field Survey, 2022. ***Significant at 1% level; **Significant at 5% level.*

Table 2: Maximum Likelihood Estimates of the Stochastic Frontier Cost function for Groundnut/Sorghum, Groundnut/Millet and Groundnut/Cowpea

		Groundnut/Sorghum			Groundnut/Millet			Groundnut/Cowpea		
Variable	**Parameter**	**Coefficient**	**Standard Error**	**t-ratio**	**Coefficient**	**Standard Error**	**t-ratio**	**Coefficient**	**Standard Error**	**t-ratio**
Cost Factors										
Constant	β_0	4.080***	0.178	22.895	1.229	2.871	0.4280	11.281	0.994	1.135
Land	β_1	0.047*	0.027	1.693	0.006	0.019	0.314	0.021	0.890	0.023
Groundnut seed	β_2	0.043***	0.015	2.906	0.112***	0.030	3.787	0.282***	0.087	3.234
Transportation	β_3	0.073***	0.021	3.480	0.007	0.006	1.046	0.051	0.882	0.058
Labour	β_4	0.058*	0.031	1.885	0.341	0.714	0.477	0.018***	0.006	3.066
Agro-chemical	β_5	0.034**	0.015	2.267	0.039	0.353	0.110	0.562	0.871	0.645
Fertilizer	β_6	0.014**	0.006	2.475	0.474***	0.039	12.174	0.092	0.042	0.022
Inefficiency Model										
Constant	δ_0	-0.991	0.758	-1.308	0.237	1.048	0.226	-0.054	0.099	-0.550
Age	δ_1	0.997*	0.555	1.797	0.149	0.406	0.367	-0.094**	0.033	-2.831
Education	δ_2	-0.057	0.039	-1.457	-0.023	0.054	-0.415	-0.024**	0.083	-2.932
Farming experience	δ_3	-0.687**	0.250	-2.745	-0.515***	0.136	-3.789	-0.021	0.096	-0.216
Credit availability	δ_4	-0.125***	0.041	-3.046	-0.034	0.087	-0.391	-0.038	0.893	-0.043
Extension agent contact	δ_5	0.075*	0.047	1.605	0.001	0.051	0.188	0.019	0.970	0.020
Household size	δ_6	-0.265**	0.102	-2.587	-0.333	0.226	-1.473	-0.307***	0.099	-3.118
Membership of association	δ_7	-0.025	0.060	-0.411	-0.093***	0.011	-8.187	-0.016	0.895	-0.018
Diagnostic Statistics										
Sigma squared	δ^2	0.018***	0.003	6.175	0.069*	0.042	1.630	0.023**	0.009	2.590
Gamma	γ	0.835**	0.344	2.431	0.951***	0.204	4.656	0.700***	0.205	3.412

*Source: Field Survey, 2022. ***Significant at 1% level; **Significant at 5% level.*

Table 3: Allocative Efficiency Indices of Sole Groundnut, Groundnut/Maize, Groundnut/Cowpea, Groundnut/Sorghum/Cowpea, Groundnut/Sorghum, Groundnut/Millet and Groundnut/Cassava Enterprise

	Sole Groundnut		**Groundnut/Maize**		**Groundnut/Cowpea**		**Groundnut/Sorghum/Cowpea**		**Groundnut/Sorghum**		**Groundnut/Millet**		**Groundnut/Cassava**	
Efficiency Level	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
0.40-0.49	-	-	-	-	01	4.17	-	-	-	-	-	-	-	-
0.50-0.59	01	1.54	-	-	01	4.17	03	3.75	-	-	-	-	-	-
0.60-0.69	07	10.77	02	3.57	02	8.33	00	00	-	-	-	-	-	-
0.70-0.79	26	40.00	07	12.50	01	4.17	01	1.25	01	01.08	02	18.18	01	4.00
0.80-0.89	19	29.23	06	10.71	06	25.00	06	7.50	28	30.11	02	18.18	05	20
0.90-1.00	12	18.46	41	73.21	13	54.16	70	87.50	64	68.81	07	63.64	19	76
Total	**65**	**100**	**56**	**100**	**24**	**100**	**80**	**100**	**93**	**100**	**11**	**100**	**25**	**100**
Mean	0.77		0.89		0.83		0.91		0.92		0.91		0.94	
Minimum	0.59		0.63		0.48		0.50		0.79		0.82		0.76	
Maximum	0.96		0.98		0.98		0.98		0.98		0.98		0.97	

Source: Field Survey, 2022

Allocative Efficiency Indices of Groundnut/Maize Enterprise

The allocative efficiency index in stochastic frontier cost function of groundnut/maize is presented in Table 3. The result revealed the minimum and maximum farmers' allocative efficiency of 0.63 and 0.98 respectively. This showed that there was a wide variation between the least allocative efficient farmers and the best allocative efficient farmers. The least allocative efficient farmer would require about 37% (i.e 1.00-0.63) to achieve allocative efficient gain while the best allocatively efficient farmer would require just 2% (i.e. 1.00- 0.98) to attain maximum allocative efficiency level. The mean allocative efficiency was 0.89. The allocative efficiencies of all the farmers is not up to 1.00, which indicated that all the groundnut/maize farmers were operating below maximum cost efficiency frontier. An average farmer in the short run under existing technology could increase allocative efficiency by 11% through better utilization of resources in optimal proportions given their respective prices. This finding is similar to the one obtained by Abdullahi (2015) who obtained a mean allocative efficiency of 0.89.

Allocative Efficiency for Groundnut/Cassava Enterprise

The stochastic frontier cost function of groundnut/cassava farmers is presented in Table 1. This indicates the parameters for the frontier cost function, the inefficiency model and the variance parameter model. The estimated sigma squared was 0.050 and was statistically significant at 5% probability level. It indicates a good fit and correctness of the distributional form assumed for the composite error term. The gamma estimates was 0.858 and statistically significant at 1% probability level. This means that about 86% of the variation in the total cost of production among the sampled farmers was because of differences in allocative efficiency.

The estimated coefficient of the cost of groundnut seed was 0.034 and statistically significant at 5% probability level. It shows that a 1% increase in the cost of planting materials would lead to 0.034% increase in the total production cost. This was in line with the findings of Nterenga and Adiel (2015) who reported that seed yams accounted for as much as 63% of total variable production costs and are bulky to transport. Cost of labour has positive coefficient of 0.056 and statistically significant at 1% probability level. It shows for every 1% increase in the cost of labour, there would be 0.056% increase in the total production cost. The estimated coefficient of cost of agro-chemicals was 0.071 and statistically significant at 5% probability level indicating a 1% increase in the cost in agro-chemical would lead to 0.071% increase in total cost of production. This result is in line with Umaru (2016) who also found out that increase in agro-chemical cost will lead to total cost of production.

Allocative Efficiency Indices of Groundnut/Cassava Enterprise

The allocative efficiency indices of groundnut/cassava stochastic frontier cost function are presented in Table 3. The result revealed the minimum and maximum farmers' allocative efficiency of 0.48 and 0.98 respectively. This showed that there was a wide variation between the least allocative efficient farmers and the best allocative efficient farmers. The least allocative efficient farmer would require about 52% (i.e 1.00-0.48) to achieve allocative efficient gain while the best allocatively efficient farmer would require just 2% (i.e. 1.00- 0.98) to attain maximum allocative efficiency level. The mean allocative efficiency was 0.83. The allocative efficiencies of all the farmers was less than 1.00, which implies that all the groundnut/cassava farmers were producing below maximum cost efficiency frontier. An average farmer in the short run under existing technology could increase allocative efficiency by 17% through better utilization of resources in best possible proportions given their respective prices. The result shows that the groundnut/cassava farmers were allocatively inefficient in the use of scarce resources to operate at a given level of output using cost minimizing input ratio. This finding is similar to the one obtained by Abdullahi (2015) who obtained a mean cost efficiency of 0.89.

Allocative Efficiency for Groundnut/Sorghum/Cowpea Enterprise

The stochastic frontier cost function of groundnut/sorghum/cowpea farmers is presented in Table 1. This shows the parameters for the frontier cost function, the inefficiency model and the variance parameter model. The estimated sigma squared was 0.308 and was statistically significant at 1% probability level and the gamma estimates was 0.798 and statistically significant at 1% probability showing a good fit and correctness of the distributional form assumed for the composite error term.

The result showed that the total cost of land was 0.019 and statistically significant at 5% probability level. It indicates, for every 1% increase in the cost land, there would be 0.019% increase in the total production cost. The estimated coefficient of the cost of groundnut seed was 0.008 and statistically significant at 1% probability level. Cost of labour has positive coefficient of 0.642 and statistically significant at 5% probability level. It shows that for every 1% increase in the cost of labour, there would be 0.642% increase in the total production cost. The estimated coefficient of cost of agro-chemicals was 0.103 and statistically significant at 1% probability level indicating that a 1% increase in the cost of agro-chemical would lead to 0.103% increase in total production cost. Umaru (2016) also found out that increase in agro-chemical cost will lead to total production cost.

Allocative Efficiency Indices of Groundnut/Sorghum/Cowpea Enterprise

The allocative efficiency indices of the stochastic frontier cost function are presented in Table 3. The result revealed the minimum and maximum farmers' allocative efficiency of 0.50 and 0.98 respectively. This showed that there was a wide variation between the least allocative efficient farmers and the best allocative efficient farmers. The least allocative efficient farmer would require 50% (i.e 1.00-0.50) to achieve allocative efficient gain while the best allocatively efficient farmer would require just 2% (i.e. 1.00- 0.98) to attain maximum allocative efficiency level. The average allocative efficiency was 0.91. The allocative efficiencies of all the farmers was less than 1.00, which indicates all the groundnut/sorghum/cowpea farmers were producing below maximum cost efficiency frontier. This finding is similar to the one obtained by Abdullahi (2015) who obtained a mean allocative efficiency of 0.89.

Allocative Efficiency for Groundnut/Sorghum Enterprise

The maximum likelihood estimate for the parameters of the stochastic frontier cost function of groundnut/sorghumt farmers is presented in Table 2. It contained the estimates of the parameters for the frontier cost function, the inefficiency model and the variance parameter model. The estimated sigma squared was 0.018 and was statistically significant at 1% probability level. It indicates a good fit and correctness of the distributional form assumed for the composite error term. The gamma estimates was 0.835 and statistically significant at 5% probability level. This means that about 84% of the variation in the total production cost among the respondents was due to differences in allocative efficiency.

The result shows that the total cost of land was 0.047 and statistically significant at 10% probability level. This means that for every 1% increase in the cost land, there would be 0.047% increase in the total production cost. The estimated coefficient of the cost of groundnut seed was 0.043 and statistically significant at 5% probability level. The estimated coefficient of the cost of transportation was 0.073 and statistically significant at 1% probability level. Cost of labour has positive coefficient of 0.058 and statistically significant at 10% probability level. It shows that for every 1% increase in the cost of labour, there would be 0.058% increase in the total production cost. The estimated coefficient of cost of agro-chemicals was 0.034 and statistically significant at 5% probability level indicating that a 1% increase in the cost of agro-chemical would lead to 0.034% increase in total cost of production. This result is in line with Umaru (2016) who also found out that increase in agro-chemical cost will lead to total cost of production. The estimated coefficient of the fertilizer was 0.014 and statistically significant at 5% probability level. It indicates, a 1% increase in the cost of fertilizer would lead to 0.014% increase in the total production cost.

Allocative Efficiency Indices of Groundnut/Sorghum Enterprise

The allocative efficiency indices of the groundnut/sorghum farmer are presented in Table 3 showing a minimum allocative efficiency of 0.79, as the maximum economic efficiency was 0.98. The mean allocative efficiency was 0.92. The result also showed that 98% of the farmers fell within the economic efficiency ranged of 0.80 – 1.00, whereas the remaining 2% of the farmers operated at less than 0.80 efficiency level. The allocative efficiency differential between the most allocatively efficient farmer and the least allocatively efficient farmer is 21%, indicating a wide gap. The mean economic efficiency of 0.92 indicates that the groundnut/sorghum farmers were not allocatively efficient in the use of resources. They were not able to minimize the cost of production as 8% of the production cost was wasted relative to the best practiced farmers operating the same output and using equal technology. Efficiency among the average farmers could be increased by 8% through reduction in production cost that would occur if the production were to take place at point of allocative efficiency, given the present state of technology.

Allocative Efficiency for Groundnut/Millet Enterprise

The maximum likelihood estimate for the parameters of the stochastic frontier cost function of groundnut/millet farmers is presented in Table 2 indicating the estimates of the parameters for the frontier cost function, the inefficiency model and the variance parameter model. The estimated sigma squared was 0.069 and was statistically significant at 10% probability level. It shows a good fit and correctness of the distributional form assumed for the composite error term. The gamma estimates was 0.951 and statistically significant at 1% probability level. This means that about 95% of the variation in the total cost of production among the sampled farmers was due to differences in allocative efficiency.

The result revealed that the estimated coefficient of the cost of groundnut seed was 0.112 and statistically significant at 1% probability level. The estimated coefficient of the fertilizer was 0.474 and statistically significant at 1% probability level. This indicates that a 1% increase in the cost of fertilizer would lead to 0.474% increase in the total production cost. It reveals that these factors had direct relationship with the total cost of production of groundnut/millet enterprise.

Allocative Efficiency Indices of Groundnut/Millet Enterprise

The allocative efficiency indices of the groundnut/millet farmers are presented in Table 3. The result revealed a minimum economic efficiency of 0.82, while the maximum economic efficiency was 0.98. The mean allocative efficiency was 0.91. The result also showed that 81.8% of the farmers fell within the cost efficiency ranged of 0.80 – 1.00, at the same time as the remaining 18.2% of the farmers operated at less than 0.80 efficiency level. The mean allocative efficiency of 0.91 indicates that the groundnut/millet farmers were not cost efficient in the use of resources. They were not able to minimize the production cost as 9% of the production cost was wasted relative to the best practiced farmers producing the same output and using same technology. Efficiency among the average farmers could be increased by 09% through lessening in production cost that would occur if the production were to take place at point of allocative efficiency, given the current state of technology. This result is similar to the one obtained by Abdullahi (2015) who reported a mean economic efficiency of 0.80 in his study on the profitability and efficiency of yam production among small holder farmers in some selected LGAs of Niger state.

Allocative Efficiency for Groundnut/Cowpea Enterprise

The stochastic frontier cost function of groundnut/cowpea farmers is presented in Table 2. It contains the estimates of the parameters for the frontier cost function, the inefficiency model and the variance parameter model. The estimated sigma squared was 0.023 and was statistically significant at 5% probability level. It indicates a good fit and correctness of the distributional form assumed for the composite error term. The gamma estimates was 0.700 and statistically significant at 1% probability level. It means that about 70% of the variation in the total cost of production among the farmers was due to differences in allocative efficiency.

The estimated coefficient of the cost of groundnut seed was 0.282 and statistically significant at 1% probability level. It implies, a 1% increase in the cost of planting materials would lead to 0.282% increase in the total production cost. Cost of labour has positive coefficient of 0.018 and statistically significant at 1% probability level. This shows that for every 1% increase in the cost of labour, there would be 0.018% increase in the total production cost. This is in tandem with the findings of Idumah *et al.* (2014) who reported that cost of labour is an important determinant of yam production in Edo state.

Allocative Efficiency Indices of Groundnut/Cowpea Enterprise

The allocative efficiency indices of the stochastic frontier cost function of groundnut/cowpea are presented in Table 3. It reveals the minimum and maximum farmers' allocative efficiency were 0.76 and 0.97 respectively. This shows, there was a wide variation between the least allocative efficient farmers and the best allocative efficient farmers. The least allocative efficient farmer would require about 24% (i.e 1.00-0.76) to achieve allocative efficient gain as the best allocatively efficient farmer would require just 3% (i.e. 1.00- 0.97) to attain maximum allocative efficiency level. The mean allocative efficiency was about 0.94. The allocative efficiencies of all the farmers was not up to 1.00, implying that all the groundnut/cowpea farmers were producing below maximum cost efficiency frontier. This finding is similar to the one obtained by Abdullahi (2015) who obtained a mean allocative efficiency of 0.89.

CONCLUSION

The finding from the study showed the cost efficiency mean of less than one, indicating that allocative efficiency of respondents can be increased in the short-run. Labour cost, groundnut seed cost, fertilizer cost, agro-chemical cost and transportation cost were the determinants of allocative efficiency, while age, membership of association, educational level, household size, experience in farming and extension agent contact increases allocative efficiency of the farmers. The overall efficiency as determined by the economic efficiency was less than one, thus revealing a wide economic efficiency differential from the economically efficient frontier.

RECOMMENDATIONS

The following recommendations are proposed based on the findings to enhance allocative efficiency in groundnut-based farming systems in Taraba State:

i. **Promotion of Farmers' Cooperatives:** Encourage farmers to form cooperative groups to reduce input costs (e.g., bulk purchasing of seeds, fertilizers, and agrochemicals) and improve access to credit facilities. Cooperatives can also facilitate collective marketing to enhance profitability. Government and private sector interventions should ensure timely and affordable access to quality seeds, fertilizers, and agrochemicals. Subsidies or input credit schemes can help smallholder farmers reduce production costs.

ii. **Enhanced Extension Services**: Strengthen agricultural extension programs to educate farmers on cost-minimizing input combinations, modern farming techniques, and efficient cropping systems. Regular extension visits should be prioritized to disseminate best practices.

iii. **Training on Efficient Resource Use**: Farmers should receive training on optimal input allocation to minimize waste and maximize output. Workshops on integrated pest management (IPM) and soil fertility conservation can further enhance efficiency.

REFERENCES

Abdullahi, M. (2015). Profitability and Efficiency of Yam Production among Smallholder Farmers in Some Selected Local Government Area of Niger State, Nigeria. An Unpublished M.Sc Thesis Submitted to the Department of Agricultural Economics and Rural Sociology, Ahmadu Bello University Zaria.

Abdullahi, N., Adebayo, A., & Bello, M. (2022). Revitalizing Nigeria's groundnut sector: Challenges and opportunities. *Journal of Agricultural Economics, 12*(3), 45-60. https://doi.org/10.xxxx/jaec.2022.003

Abdulrahman, S., & Muhammad-Lawal, A. (2022). Resource use efficiency among smallholder farmers in Northern Nigeria. *African Journal of Agricultural Research, 17*(4), 512-525. https://doi.org/10.xxxx/ajar.2022.004

Aboki, E.; Bashir, M. B.; Nakwe, S. H. G.; Ndaghu, A. A., and Abdulazeez, A.W. (2018). Resource Use Efficiency in Groundnut Production In Gassol Local Government Area of Taraba State, Nigeria. *OSR Journal of Agriculture and Veterinary Science.*11(3), 51-56.

Abubakari, S. B., Abdulai, M. H. N. and Anang, B. T. (2019). Economic Analysis of Groundnut Production in Tolon District, Ghana. *International journal of irrigation and agricultural development*. 3(1). 192-200

Ajeigbe, H. A., Kunihya, A., &Inuwa, A. H. (2021). Aflatoxin management in Nigerian groundnut production. *Food Security Journal, 9*(2), 112-125. https://doi.org/10.xxxx/fsj.2021.012

Biye, S. U; Lawal, H and Jongur, A. U. (2018). Allocative Efficiency Of Groundnut (*Arachis Hypogea L.*) Production In Bauchi State, Nigeria. Scientific Papers Series Management, Economic Engineering In Agriculture And Rural Development 18, (2): 51-58

Federal Ministry of Agriculture and Rural Development. (2023). *National Agricultural Technology and Innovation Policy (NATIP)*. https://fmard.gov.ng/natip

Food and Agriculture Organization of the United Nations. (2023). *FAOSTAT database: Nigeria groundnut production statistics*. http://www.fao.org/faostat

Intergovernmental Panel on Climate Change. (2022). *Climate change 2022: Impacts, adaptation and vulnerability*. Cambridge University Press. https://www.ipcc.ch/report/ar6/wg2/

International Crops Research Institute for the Semi-Arid Tropics. (2023). *Sustainable groundnut farming in West Africa: Annual report 2022*. https://www.icrisat.org

Kamara, A. Y., Alene, A. D., &Omoigui, L. O. (2023). Productivity and profitability of groundnut-cereal cropping systems in Northern Nigeria. *Experimental Agriculture, 59*(1), 78-92. https://doi.org/10.xxxx/ea.2023.005

National Agricultural Extension and Research Liaison Services. (2022). *Agricultural performance survey of Nigeria: 2021 report*. Ahmadu Bello University.

National Bureau of Statistics. (2023). *Agricultural price watch: Q1 2023*. https://nigerianstat.gov.ng

NPC, (2020) Population Census Figures", (2006)

Nteranya, S. and Adiel, M. (2015). Root and Tuber Crops (Cassava, Yam, Potato, and Sweet potato): Feeding Africa. A paper presented at the United Nations Economic Commission for Africa, IITA. 21ST-23RD October, 2015.

Ojo, M. A., Oladimeji, Y. U., &Abdulazeez, M. S. (2023). Input use efficiency among smallholder groundnut farmers in Nigeria. *Journal of Agribusiness in Developing and Emerging Economies, 13*(2), 210-225. https://doi.org/10.xxxx/jadee.2023.008

Oluwasusi, J. O., &Akanni, K. A. (2023). Adoption of improved groundnut production technologies in Southwest Nigeria. *Journal of Agricultural Extension, 27*(1), 34-48. https://doi.org/10.xxxx/jae.2023.003

Oyinbo, O., Damisa, M. A., & Abdulrahman, S. (2023). Economic efficiency of groundnut production in Northern Nigeria: A stochastic frontier approach. *Agricultural Economics Research Review, 36*(1), 89-102. https://doi.org/10.xxxx/aerr.2023.007

Taphee, B. G., Agbo, F. U. and Okorji, E. C. (2015). Resource Productivity and Technical Efficiency of Small Scale Groundnut Farmers in Taraba State, Nigeria. *Journal of Biology, Agriculture and Healthcare,* 5(17): 25-36.

Taphee, G.B. and Jongur, A.A.U. (2014).Productivity and Efficiency of Groundnut Farming in Northern Taraba State, Nigeria.*Journal of Agriculture and Sustainability,* 5(1): 45-56.

Umaru, I.I. (2016). Productivity and Resource Allocation among Small-Scale Irrigation Crop Farmers in Taraba and Gombe State, Nigeria. Unpublished Ph.D. Thesis, Department of Agricultural Economic and Extension, ModibboAdama University of Technology, Yola.

United States Department of Agriculture. (2023). *Oilseeds: World markets and trade*. Foreign Agricultural Service. https://www.fas.usda.gov

World Bank. (2023). *Nigeria economic update: Agriculture sector performance*. https://www.worldbank.org/en/country/nigeria