JOURNAL OF AGRICULTURAL ECONOMICS, EXTENSION & SCIENCES
Official Journal of the College of Agricultural Economics and Extension
www.jaees.org
www.uam.edu.ng
Jaees Vol. 13 No.2 2026, Page 197 - 215
ISSN (Print) 2545-5179, ISSN (Online) 2714-5018

GENDER-BASED ANALYSIS OF ECONOMIC EFFICIENCY OF BAMBARA NUT PRODUCTION AMONG RURAL FARMERS IN THE NORTHEAST NIGERIA

[*1]Osayi, C.P., [1]Onogwu, G.O. and [2]Nnamerenwa, G.C.

[*1]Department of Agricultural Economics and Extension, Faculty of Agriculture and Life Sciences, Federal University Wukari, Taraba State, Nigeria

[2]National Root Crops Research Institute (NRCRI) Umudike, Abia State, Nigeria

Email: osayichinwe@gmail.com 08063782889

Abstract

This study analysed the gender-based differences in economic efficiency among Bambara nut farmers in Northeast Nigeria. It specifically estimates the economic efficiency levels of male and female farmers, compares their performance, and identifies the determinants of inefficiency across gender. A multistage sampling technique was employed to select 360 male and 360 female smallholder farmers. Primary data were obtained through a structured questionnaire administered using the Paper-Assisted Personal Interview (PAPI) approach. Analytical methods included descriptive statistics, an independent z-test, and the Cobb-Douglas stochastic frontier cost function model. Results indicated that female farmers exhibited significantly higher economic efficiency than their male counterparts, with mean efficiency scores of 0.805 and 0.762, respectively. The difference was statistically significant at the 1% level. Input factors such as labor, land rent, seed quantity, capital, and Bambara nut output were key drivers of efficiency for both genders. However, determinants of inefficiency varied: for male farmers, significant factors included age, education level, household size, cooperative membership, extension visits, credit access, training in Bambara nut production, and off-farm income. For female farmers, inefficiency was influenced by education, household size, farming experience, extension contact, cooperative membership, distance to farm, perceived price fluctuations, and land ownership. The findings underscored the importance of gender-sensitive agricultural policies aimed at improving equitable access to resources, extension services, and capacity-building programs. Targeted interventions that address gender-specific constraints can enhance overall efficiency, productivity, and inclusive growth in Nigeria's agricultural sector.

Keywords: *Gender, Analysis, Economic efficiency, Bambara nut, Production.*

1.0 Introduction

Agricultural development remains a cornerstone of economic transformation in sub-Saharan Africa, with a significant portion of the population depending on small-scale farming for food security and income generation. In Nigeria, the agricultural sector contributes notably to employment, livelihoods, and rural economic advancement. Yet, within this vast sector, certain crops remain underutilized despite their potential to mitigate food insecurity and enhance environmental sustainability. One such crop is Bambara nut. The Bambara nut (*Vigna subterranea*), a legume native to Africa, offers vast potential for improving food security and economic stability, particularly in climate-sensitive regions such as Northeast Nigeria. Known for its drought tolerance, nitrogen-fixing ability, and high nutritional value including approximately 63% carbohydrates, 19% protein, and 6.5% oil, the crop represents a low-cost, high-return option for smallholder farmers (Mohammed & Mhya, 2021; Nguyen, 2019). Despite these advantages, it remains largely neglected and underutilized in formal agricultural systems.

In Northeast Nigeria, climate variability, poverty, and fragile ecosystems prevail and Bambara groundnut farming represents a sustainable alternative to input-intensive crops. The crop is suitable for environments with poor soils and low water conditions and this makes it ideal for most marginal farming communities (Mkandawire, 2007; Mayes et al., 2019). The crop is commonly cultivated by women in mixed-cropping systems, which enhances household food security and provides off-season income. However, despite these advantages, the planting of the crop remains marginalised in most formal seed systems, input access, and agricultural programmes in this area.

Farmers face limited availability of improved seeds, agronomic support, markets, and access to credit, all of which constrain efficiency and performance. Disparagingly, there exists lack of study on the economic efficiency of BG farmers along gender-line and this is seen as a key gap in existing literature on Bambara groundnut production.

Economic efficiency is generally defined as the optimal use of inputs to achieve maximum output and this is essential at the farm level when identifying gaps in the productivity of farmers. In this study, economic efficiency is referred to as the ability of BG farmers to maximize production and profits using the least cost combination of land, labour, seeds, and agro-chemicals. The dynamic of this phenomenon can be seen when examined through a gender lens especially in rural Nigeria where unequal access to resources exists in the farming operations of male and female farmers. In Northeast Nigeria, both male and female farmers engage in Bambara groundnut farming, but differences in access to land, capital, labour, and extension services influence their efficiency and productivity. These gender-based inequalities are well documented and are reflected in differential efficiency levels. Women, who form a significant proportion of the agricultural labour force, often face restricted access to credit, land, inputs, and decision-making power (Aviara et al., 2013).

Northeast Nigeria, which is characterised by arid conditions, fragile ecosystems, and high poverty levels offers a strategic milieu for promoting climate-resilient crops such as Bambara nut. The existence of gender differences in this region are deep-rooted and commonly promoted by unfair socio-cultural norms, insecure land tenure, and lack of institutional support. In forming inclusive agricultural policy, the need to understand gender differences in economic efficiency is very relevant. While previous studies have

explored production constraints and nutritional benefits, there is limited empirical analysis of economic efficiency, particularly from a gender-disaggregated perspective. Most studies on Bambara nut in Nigeria overlook gender, masking critical differences in access to resources and decision-making power. Thus, interventions remain gender-blind and fail to address the specific challenges of women such as being excluded from credit schemes, extension services, and leadership structures. This deprivation hampers their productive capacity and makes their economic contributions low. It is crucial to assess the economic efficiency of Bambara nut farmers through a gender lens so as to ensure equitable agricultural development in Northeast Nigeria. This research aims at shedding light on two basic questions such as: (a) whether women are as efficient resource users as men and (b) which socio-economic factors mediate these differences. A clarification of these issues is imperative in the event of designing precision policy interventions in inputs, credit, training and extension that could raise productivity and improve resource allocation in all farming households.

2.0 Objectives of the Study

This study seeks to address these gaps by exploring the gendered dimensions of economic efficiency in Bambara nut farming. Specifically, the objectives of the study were to:

1. estimate economic efficiency of Bambara nut farmers in Northeast Nigeria along gender line.
2. compare economic efficiency between male and female Bambara nut farmers.
3. identify key determinants influencing economic efficiency of these farmers.

3.0 Methodology

3.1 *The study area*

The study was conducted in Northeast Nigeria, a geopolitical zone comprising six States: Adamawa, Bauchi, Borno, Gombe, Taraba and Yobe. It borders Chad and Cameroon to the East, Plateau and Benue to the South, Kano and Jigawa to the West, and Niger Republic to the north. The region lies between latitudes 7 degrees 30 minutes and 14 degrees North of the equator, and longitudes 9 degrees and 15 degrees east of the Greenwich meridian. Covering less than one-third of Nigeria's total landmass, it is home to approximately 26 million people, accounting for 12 percent of the national population (Worldometer, 2021). The major crops cultivated include cassava, rice, yam, maize, millet, potato, sorghum, cowpea, cotton, groundnut, Bambara nut and watermelon, alongside livestock farming. Rainfall ranges from 250 millimetres in Nguru (Borno) to 1310 millimetres in Sugu (Adamawa), while temperatures vary from 20 to 40 degrees Celsius annually (NAERLS and PCU, 2014). The region spans the Sahel, Sudan and Guinea Savanna zones, with a dry season from October to April and a rainy season from June to September, typically interrupted by the August break. Bambara nut, a seasonal legume, is widely cultivated during the rainy season.

3.2 Sampling procedure and sample size

The sampling design involved two stages of purposive and random sampling. Three States, Adamawa, Bauchi and Taraba, were purposively selected based on evidence of household Bambara nut farming. From each, six Local Government Areas with the highest farming activities were chosen, totalling eighteen. Two communities were

randomly selected from each, giving thirty-six communities. Within each, ten male and ten female farmers were stratified randomly, resulting in 360 male and 360 female respondents. The sampling frame was compiled with support from Agricultural Development Programme staff, extension agents, farmer associations and community leaders.

3.3 Sources and method of data collection

Primary data were used for the study. Data were collected from the selected BG farmers in the study areas through a validated questionnaire using the Paper Assisted Personal Interview method.

3.4 Data analytical techniques

The Cobb-Douglas Stochastic frontier cost function was used to determine the level of economic efficiency (EE) of male as well as female Bambara nut farmers in Northeast Nigeria as well as determinants of economic inefficiency. Differences between the level of economic efficiency of male and female Bambara groundnut farmers in northeast Nigeria were tested using the z-test. The Cobb-Douglas Stochastic frontier cost function that was used to determine the economic efficiency (EE) of male as well as female Bambara groundnut farmers in northeast Nigeria is expressed in its implicit form as used by Okello et al. (2019) and Okoye et al. (2007) as:

$C_i=F(W_i, Y_i; \Omega) \exp \pi_i$ ----------(1)

Where; C_i = Represents the minimum cost associated with Bambara groundnut production for i^{th} farmer; W_i = Vector of inputs prices associated with producing output Y_i of Bambara groundnut, and π_i = The composite error term which can be decomposed into δ_i - μ_i, where μ_i is the inefficiency parameter and δ_i is the stochastic term associated with

random variations in production. Ω = Vector of parameters associated with the production function. $F(.)$ = The functional relationship between cost, prices, and output. By decomposing the composite error terms, Eq. (1) can be restated as:

$C_i = F(W_i, Y_i; \Omega) \exp(\delta_i - \mu_i)$ (2)

EE would then be estimated as specified as follows

$$EE = \frac{C_i}{C_i^*} \quad (3)$$

Where, C_i = The observed cost of the i^{th} farmer for the production of Bambara groundnut, C_i^* = The frontier cost of production for Bambara groundnut which assumes an economically efficient production for the i^{th} farmer. Explicitly, the Cobb-Douglas stochastic frontier cost function that was used to estimate the economic efficiency of male as well as female Bambara groundnut producers in northeast Nigeria is specified as follows:

$$\ln C_i = \Omega_0 + \Omega_1 \ln W_1 + \Omega_2 \ln W_2 + \Omega_3 \ln W_3 + \Omega_4 \ln W_4 + \Omega_5 \ln W_5 + \Omega_6 \ln W_6 + \Omega_7 \ln Y + \delta_i - \mu_i \quad (4)$$

where; ln = Natural logarithm, Ω_0 = Constant term; $\Omega_1 - \Omega_7$ = Regression coefficients to be estimated; $\ln C_i$ represents total input cost of the i^{th} farm, W_1 is average daily wage rate per manday, W_2 is price of fertilizer per kg, W_3 is land rent in naira per hectare, W_4 is price of Bambara groundnut seed planted in naira per kg, W_5 is price of agrochemicals used in naira. W_6 is capital input in naira made up of depreciation charges on farm tools and equipment, interest on borrowed capital and rent on land, Y is output of Bambara groundnut in kg adjusted for statistical noise, while δ_i and v_i are as defined earlier. The determinants of economic inefficiency which represents the factors that determine cost of Bambara nut production for male and female farmers in northeast Nigeria is specified:

$$EE_i = \delta_0 + \delta_1 \ln W_1 + \delta_2 \ln W_2 + \delta_3 \ln W_3 + \delta_4 \ln W_4 + \delta_5 \ln W_5 + \ldots + \delta_{12} \ln W_{12} + \delta_{13} \ln W_{13} \quad (5)$$

where; EE_i = Economic efficiency for Bambara groundnut production for i^{th} farm; δ_0 = Constant; $\delta_1 - \delta_{13}$= Parameters to be estimated. W_1= Age of farmer (years); W_2= Level of education (years of formal schooling); W_3= Household size (number of people per farmer's household); W_4 = Farming experience of the farmer (number of years in Bambara nut production); W_5= Extension visits (number of visits per production cycle); W_6= Cooperative membership (1 = Member; 0 = Non-member); W_7= Amount of credit obtained (N); W_8= Distance to farm (Km); W_9 = Banditry/herdsmen attacks of farmers on farms or in the community (Dummy, Yes = 1; No = 0); W_{10} = Perceived price hike of the product (Dummy, Yes = 1; No = 0); W_{11} = Land ownership status (Inheritance = 1; Otherwise = 0); W_{12}= Training in Bambara groundnut farming (Yes = 1; No = 0); and W_{13} = Off farm income (N). Economic efficiency (EE) also takes on values between 0 and 1, with EE of 1 representing a cost-efficient farmer. The estimates for all parameters of the stochastic production and cost frontier models and inefficiency models are simultaneously obtained using the program - Frontier Version 4.1c. The independent sample z-test use to compare the level of economic efficiency of male and female Bambara groundnut farmers in Northeast Nigeria is fitted as:

$$Z_{cal} = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{S^2\bar{x}_1}{n_1} + \frac{S^2\bar{x}_2}{n_2}}} \qquad (6)$$

Where; x_i represents the mean of economic efficiency of male Bambara groundnut producers; x_2 represents the mean of economic efficiency of female Bambara groundnut producers; S^2x_1 represents the standard deviation of economic efficiency of male Bambara groundnut producers; S^2x_2 represents the standard deviation of economic efficiency of female Bambara groundnut producers; n_1 represents the numbers of male respondents; and $n_2$represents the numbers of female respondents.

4.0 Results and Discussion

4.1 Estimation of the level of economic efficiency of BG farmers in northeast Nigeria

The Cobb Douglas stochastic frontier cost function was used to evaluate the economic efficiency of male and female Bambara groundnut farmers in Northeast Nigeria. Table 1 shows that male farmers had efficiency scores ranging from 0.532 to 0.905, with a mean of 0.762 and most (50.3%) scoring between 0.801 and 0.900. Female farmers recorded scores between 0.406 and 0.981, with a higher mean of 0.805 and the majority (68.3%) falling within the same efficiency range.

Table 1: Economic efficiency levels of male and female BG farmers in northeast Nigeria

Economic Efficiency Level	Male		Female	
	Frequency	Percent	Frequency	Percent
0.401 - 0.500	-	-	10	2.8
0.501 - 0.600	19	5.3	22	6.1
0.601 - 0.700	18	5	12	3.3
0.701 - 0.800	141	39.2	13	3.6
0.801 – 0.900	181	50.3	246	68.3
0.901 – 1.000	1	0.3	57	15.8
Total	360	100	360	100
Mean	0.762		0.805	
Maximum	0.905		0.981	
Minimum	0.532		0.406	

Source: Field survey (2024)

Table 1 shows that female BG farmers possess higher economic efficiency scores than their male counterparts. This implies that although both groups are economically efficient, female farmers demonstrated superior efficiency and commitment to Bambara nut farming. This superior efficiency among female farmers could be attributed to their meticulous management and optimization of available resources, which justifies their higher productivity in the study area. Recent empirical studies, such as those by Adewale

and Oyeyemi (2022), supported the finding that women often achieve higher productivity when given equal access to resources, underscoring the importance of empowering female farmers to enhance overall agricultural productivity. The mean economic efficiency (76.2%) for male farmers suggests that they could potentially increase Bambara nut production by an average of 23.8% if they operated at full technical and allocative efficiency levels. Additionally, the male farmer with the average level of economic efficiency would achieve a cost saving of approximately 15.8% calculated as (1 - 0.762/0.905)*100) to reach the status of the most economically efficient producer. Similarly, the mean economic efficiency (80.5%) for female farmers indicates they could increase Bambara nut production by an average of 19.5% if they operated at full technical and allocative efficiency levels. Furthermore, the female farmer with the average level of economic efficiency would enjoy a cost saving of about 17.94% calculated as (1 - 0.805/0.981)*100) to attain the status of the most economically efficient producer.

4.2 Comparison of the level of economic efficiency of BG farmers in the Northeast Nigeria

Table 2 presents the result of the comparative analysis of the level of economic efficiency of male and female Bambara nut farmers in the Northeast Nigeria, which was done using an independent z-test. Table 2 indicates that female farmers exhibited significantly higher EE than male farmers ($z = -6.316$, $p < 0.01$). The results suggest that female Bambara nut farmers are more economically efficient than their male counterparts across the study area.

Table 2: Test of significance difference in economicefficiency between male and female BG farmers in the Northeast Nigeria

Variables	Mean	Std. Deviation	Std. Error Mean	Df	z-statistic
Male	0.762	0.073	0.004		
Female	0.805	0.109	0.006		
Difference	-0.043	0.130	0.007	718	-6.316***

Source: Field survey (2024)
Note: *** signifies 1% level of significance.

This implies that women in the study area utilized available resources more effectively, leading to lower production costs and higher productivity than their male counterparts, despite the established notion that women have limited access to resources in some cases. The demonstration of superiority in resource allocation, cost management, and operational effectiveness by female BG farmers leading to higher efficiency may be attributed to a stronger commitment to farming, more prudent financial decisions, or greater attention to detail in managing inputs.

4.3 Determinants of Economic Efficiency in Bambara Nut Production

The result of the maximum likelihood estimates of the stochastic cost frontier analysis of male and female Bambara nut farmers in the Northeast Nigeria achieved using frontier 4.1 is presented in Table 3. The stochastic cost frontier analysis highlights notable gender-based differences in the economic efficiency of Bambara nut farmers in Northeast Nigeria. Among male farmers, significant cost determinants include labour, fertilizer, and agrochemicals, while output showed a strong negative elasticity, and implies increasing returns to scale. Economic inefficiency is significantly reduced by education, household size, farming experience, and extension visits, while it is heightened by cooperative membership, credit obtained, and off-farm income. The sigma-squared (σ^2) value of 0.322, significant at the 1% level, confirms the model's goodness of fit. The

gamma value (γ) of 0.812 indicates that 81.2% of the variation in production costs is due to economic inefficiency. The likelihood ratio (LR) test value of 24.062, is below the critical values of 35.556 at 1% and 29.545 at 5%, and indicates the presence of economic inefficiency. The log likelihood function value of 150.702 supports the model's robustness, highlighting significant cost inefficiency among male farmers.

Table 3: Maximum likelihood estimates of the stochastic cost frontier analysis of male and female Bambara groundnut farmers in northeast Nigeria

Variable	Parameters	Male Coefficient	t-value	Female Coefficient	t-value
Constant	Ω_0	0.614	5.459***	0.434	9.411***
Labour (₦/manday)	Ω_1	0.786	3.612***	0.629	5.376***
Fertilizer (₦)	Ω_2	0.588	2.321**	0.468	1.247
Land rent (₦/ha)	Ω_3	0.033	0.906	0.061	2.272**
Bambara nut seed (₦)	Ω_4	0.01	0.096	0.099	1.163
Agrochemicals(₦)	Ω_5	0.287	4.455***	0.503	5.788***
Capital (₦)	Ω_6	0.004	0.059	0.247	2.942***
Bambara nut output (₦)	Ω_7	-0.914	-5.732***	-0.125	-4.532***
Inefficiency model					
Constant	δ_0	5.722	7.635***	12.384	9.335***
Age of farmer	δ_1	0.865	3.642***	-0.254	-0.639
Level of education	δ_2	-0.004	-2.246**	-0.665	-2.361**
Household size	δ_3	-0.014	-4.432***	0.392	2.442***
Farming experience	δ_4	-0.222	-2.447**	0.709	3.414***
Extension visits	δ_5	-0.083	-2.703***	0.092	2.721***
Cooperative membership	δ_6	0.747	3.708***	1.068	2.596**
Amount of credit obtained	δ_7	0.296	2.647**	0.094	0.567
Distance to farm	δ_8	0.068	-0.267	0.632	3.187***
Banditry/herdsmen attacks	δ_9	0.116	-1.281	-0.017	-0.194
Perceived price hike	δ_{10}	0.073	-1.886	-1.116	-2.865***
Land ownership status	δ_{11}	0.024	0.22	0.421	2.165**
Training in Bambara farming	δ_{12}	0.047	2.423**	-0.093	-0.745
Off farm income	δ_{13}	0.356	-3.003***	0.037	0.163
Sigma-squared		0.322	6.306***	0.139	12.610***
Gamma		0.812	7.519***	0.931	9.523***
LR test		24.062		30.624	
Log likelihood function		150.702		161.049	
Total number of observations		360		360	

Source: Field survey (2024).

Kodde and Palm 1986 LR critical value = 35.556 at 1% and 29.545 at 5% significant levels

Note: *** signifies 1% level of significance, ** signifies 5% level of significance, * signifies 10% level of significance.

The result of the stochastic cost frontier analysis for male farmers, shows that age is positively related to inefficiency at the 1% level, indicating reduced efficiency with ageing, consistent with Bassey et al. (2022). Education level shows a significant negative relationship, implying higher education enhances efficiency (Afolabi et al., 2021). Household size and farming experience both have negative coefficients at 1% and 5% significance levels respectively, showing their contribution to reducing inefficiency (Eze et al., 2023; Adamu and Garba, 2020). Extension visits significantly reduce inefficiency, confirming Yusuf et al. (2023). However, cooperative membership, credit access, training, and off-farm income are all positively related to inefficiency at 1% and 5% levels, suggesting possible structural or implementation issues. This supports the findings of Bello and Musa, (2023) Adewale and Ogunleye, (2022) and Danjuma and Okorie, (2022).

For female farmers, labour, agrochemicals, capital, and land rent were the factors that drives production cost, with output also showing negative elasticity (-0.125, $p<0.01$). Inefficiency is reduced by education, extension visits, and perceived price hikes, while increased household size, farming experience, distance to farm, cooperative membership, and land ownership status raise inefficiency. The sigma-squared (σ^2) value of 0.139 is significant at the 1% level, confirming the model's goodness of fit and the appropriateness of the composite error distribution assumptions. The gamma value (γ) of 0.931 indicates that 93.1% of the variation in Bambara nut production costs is due to economic inefficiency, highlighting the inadequacy of the Ordinary Least Squares (OLS) method for this data. The likelihood ratio (LR) test value of 30.624, although not surpassing the critical value thresholds of 35.556 at 1% and 29.545 at 5%, still suggests

the presence of economic inefficiency. The log likelihood function value of 161.049 further supports the model's robustness, indicating significant cost inefficiency in the production process of Bambara nuts, as female farmers are not fully economically efficient. The variable of education negatively affects economic inefficiency at 5%, suggesting that higher level of education reduces economic inefficiency and improves efficiency. Household size, farming experience, and extension visits are positively associated with economic inefficiency at 1% level, suggesting that these factors may increase cost burdens or limit adaptability (Bello and Musa, 2023; Usman and Callo-Concha, 2021). Distance to farm was positively related to economic inefficiency at the 1% level of significance. This indicates that greater distances to farms contribute to increased economic inefficiency among female BG farmers. Longer distances can lead to higher transportation costs and time inefficiencies, adversely impacting farm operations. This aligns with Yusuf et al. (2023) that emphasized the significance of proximity in agricultural productivity. Perceived price hike had a negative relationship with economic inefficiency at the 1% level of significance, indicating that perceptions of rising prices can lead to better efficiency. Farmers may respond to anticipated price increases by improving efficiency to maintain profitability. This aligns with Akinyemi et al. (2022) who stated that market expectations can influence farming practices. Land ownership status (0.421) also exhibited a positive relationship with economic inefficiency at the 5% level of significance, suggesting that women who do not own the land they farm may face challenges that lead to inefficiencies. Non-ownership can limit their investment in improvements and reduce their overall productivity. This finding is consistent with Ayinde et al. (2023) who stressed the significance of land tenure security in agricultural

performance. These findings underscore the importance of gender-specific policy interventions that promote equitable access to productive inputs, training, extension services, and infrastructure.

5.0 Conclusion and Recommendations

This study has shown that there exists a clear gender-based division of labour in Bambara nut farming in the Northeast Nigeria. Female farmers consistently outperformed their male counterparts in economic efficiency, as confirmed by significant z-test results. Their superior efficiency stems from better resource management and cost optimization. For male farmers, key efficiency drivers include labour, fertilizer, agrochemicals, and output, while inefficiency is significantly influenced by age, education, household size, cooperative membership, extension visits, credit access, training, and off-farm income. Among females, efficiency is driven by labour, land rent, agrochemicals, capital, and output, whereas inefficiency is linked to education, household size, farming experience, extension visits, cooperative membership, distance to farm, perceived price hikes, and land ownership status. These findings call for targeted interventions that leverage the strengths of female farmers, particularly in resource use and decision-making, through cross-learning platforms such as collaborative workshops. Equitable policies on input access, land tenure, credit, and extension services are essential to enhance efficiency across both genders.

References

Adamu, S. and Garba, M.S. (2020). The impact of farming experience on agricultural productivity in Northern Nigeria. *Journal of Agricultural Economics*, 27(3): 255–268.

Adewale, F.O. and Ogunleye, M.K. (2022). Effectiveness of training programs in agricultural production in Nigeria. *International Journal of Agricultural*

Extension, 15(1): 45–57.

Afolabi, J.A., Balogun, O.L. and Olatunde, B.M. (2021). Influence of farmers' age on agricultural productivity in Nigeria. *Journal of Agricultural Research and Development*, 10(2): 98–105.

Akinyemi, A.I., Balogun, O.L. and Fashina, O.E. (2022). Cooperative membership and farming efficiency in Nigeria: Myth or reality? *International Journal of Agricultural Sustainability*, 20(3): 155–167.

Aviara, N.A., Lawal, A.A., Atiku, A.A. and Haque, M.A. (2013). Bambara groundnut processing, storage and utilization in North Eastern Nigeria. *Continental Journal of Engineering Sciences*, 8(1): 28–36.

Ayinde, O.E., Adeoti, A.I. and Balogun, O.S. (2023). Labour and capital investment in Nigerian agriculture: Implications for policy and practice. *Agricultural Economics Research Review*, 35(1): 78–90.

Bassey, E.T., Akpan, U.S. and Udoh, I.U. (2022). Age-related changes and their effects on farming efficiency in Nigeria. *Journal of Agricultural Research and Development*, 41(5): 375–392.

Bello, R.M. and Musa, Y.A. (2023). Cooperative societies and agricultural inefficiency: A paradox in rural Nigeria. *Journal of Cooperative Studies*, 30(3): 302–320.

Dagachi, M. and Olorunsanya, E. (2023). Technical efficiency of Bambara nut production in Niger State, Nigeria. *Journal of Agripreneurship and Sustainable Development*, 6: 56–64. https://doi.org/10.59331/jasd.v6i1.392

Eze, C.C., Nweke, F.N. & Nwosu, L.C. (2023). Household size and agricultural efficiency: The role of family labour in rural farming systems. *Agricultural Economics Review*, 19(6): 405–419.

Girei, A.A., Dire, B., Yuguda, R.M. and Salihu, M. (2014). Analysis of productivity and technical efficiency of cassava production in Ardo-Kola and Gassol LGAs of Taraba State, Nigeria. *Agriculture, Forestry and Fisheries*, 3(1): 1–5. doi:10.11648/j.aff.20140301.11

Mayes, S., Ho, W.K., Chai, H.H., Gao, X., Kundy, A.C., Mateva, K.I., Zahrulakmal, M., Hahivee, M.K.I.M., Kendabie, P., Licea, L.C.S., Massawe, F., Mabhaudhi, T., Modi, A.T., Berchie, J.N., Amoah, S., Faloye, B., Abberton, M., Olaniyi, O. and Azzam-Alli, S.N. (2019). Bambara groundnut: An exemplar underutilized crop

for resilience under climate change. *Planta*, 250(3): 803–820.

Mkandawire, C.H. (2007). Review of Bambara groundnut production in sub-Saharan Africa. *Agricultural Journal*, 2: 464–470.

Mohammed, A. and Mhya, H.D. (2021). Evaluation of phytochemical constituents, proximate contents and glycemic index of Bambara groundnut (Vigna subterranea L. Verdc) varieties grown in Northeastern Nigeria. *African Journal of Biochemistry Research*, 15(2): 22–27. https://doi.org/10.5897/AJBR2021.1120

Ndukwu, P.C., Nwaru, J.C. and Okoye, B.C. (2010). Gender and relative economic efficiency in sweet potato farmers of Imo State, Nigeria: A stochastic cost frontier approach. *The Nigerian Agricultural Journal*, 41(1): 65–70.

Nguyen, V.Q. (2019). Symbiosis between *Chamaecrista fasciculata* and nitrogen-fixing bacteria: A review. https://digitalcommons.lmu.edu/cgi/viewcontent.cgi?article=1286andcontext=honors-thesis

Okello, D.M., Bonabana-Wabbi, J. and Mugonola, B. (2019). Farm level allocative efficiency of rice production in Gulu and Amuru Districts, Northern Uganda. *Agricultural and Food Economics*, 7: 19. https://doi.org/10.1186/s40100-019-0140-x

References

Abah, D., Esheya, S. E., & Ochoche, C. O. (2021). Effect of Maize Production on Agricultural Output in Nigeria (1981-2019): Implication for Sustainable Development. International Journal Of Agricultural Economics, Management And Development (IJAEMD): 9(1): 42–54.

Adeniyi, O. R., & Ogunsola, G. O. (2014). Cocoa Production and Related Social-Economic and Climate Factors: A Case Study of Ayedire Local Government Area of Osun State, Nigeria. Agricultural Science, 2(4): 1–13. https://doi.org/10.12735/as.v2i4p01

Anania, P. & Rwekaza, G. C. (2016). The determinants of success in agricultural marketing co-operatives in tanzania: the experience from mweka sungu, mruwia and uru north njari agricultural marketing co- operatives in moshi district. European Journal of Research in Social Sciences, 4(3): 62–75.

Asghar, N., & Salman, A. (2018). Impact of agriculture credit on food production and food security in Pakistan. Pakistan Journal of Commerce and Social Sciences (PJCSS): 12(3): 851–864.

Ehui, S., & Tsigas, M. (2014). The Role of Agriculture in Nigeria ' s Economic Growth : A General Equilibrium Analysis. Draft Prepared for Presentation at the 27th Conference of the International Association of Agricultural Economists (IAAE): 16-22 August 2009, Beijing, China, July, 1–13.

Fomyol, P. E., & Tata, L. A. (2019). Evaluation of the National Special Programme on Food Security (SPFS) in Plateau State, Nigeria. Journal of Agriculture and Sustainability, 12(1): 1–12.

Hoffman, D. W. (2005). Co-operative Marketing http://www.eagri.org/eagri50/AECO242/pdf/lec05.pdf. In Cooperative Agricultural Marketing Institutions (p. 51).

James, A., & Joshua, M. (2014). Roles of Farmers ' Cooperatives in Agricultural Development In Sabuwa Local Government Area of Katsina State , Nigeria. Journal of Economics and Sustainable Development, 2002, 80–88.

Ndidi, D. E., & Isaac, I. (2015). The Impact of Foreign Direct Investment (FDI) on the Growth of the Nigerian Economy. International Journal of Research in Business Studies and Management, 2(3): 38–55.

Nwogwugwu, U. C. C., Nwokoye, E., & Osai, V. A. (2023). The Role of Agriculture in Economic Development in Nigeria. Journal of International Economic Relations and Development Economics, 3(1): 103–111.

Obilor, S. I. (2013). The impact of commercial banks ' credit to agriculture on agricultural development in Nigeria : An econometric analysis. International Journal of Business, Humanities and Technology, 3(1): 85–94. www.ijbhtnet.com

Odetola, T., & Etumnu, C. (2013). Contribution of Agriculture to Economic Growth in Nigeria. The 18th Annual Conference of the African Econometric Society (AES) Accra, Ghana at the Session Organized by the Association for the

Advancement of African Women Economists (AAAWE): 22nd and 23rd July, 2013, 1–28.

Ogutu, S. O., Gödecke, T., & Qaim, M. (2020). Agricultural Commercialisation and Nutrition in Smallholder Farm Households. Journal of Agricultural Economics, 71(2): 534–555. https://doi.org/10.1111/1477-9552.12359

Olayemi, F. F., Adegbola, J. A., Bamishaiye, E. I., & Awagu, E. F. (2011). Assessment of Post Harvest Losses of Some Selected Crops in Eight Local Government Areas of Rivers State, Nigeria. Asian Journal of Rural Development, 2(1): 13–23. https://doi.org/10.3923/ajrd.2012.13.23

Olowa, O. W. (2015). Marketing , Cooperative and Policies in Agriculture : Nigeria in Perspective Ph ton eBooks. In Marketing, Cooperative and Policies in Agriculture: Nigeria in Perspective.

Onah, O. G., Ume, C. O., Nwangwu, K. N., Ejiofor, E., Omeje & Oranu, C. O. (2024). Assessment of the Operational Performance of Farmers' Cooperative Societies in South East Nigeria. American International Journal of Agricultural Studies, 9(1): 17–26. https://doi.org/10.46545/aijas.v9i1.314

Osabohien, R., Afolabi, A. & Godwin, A. (2018). An Econometric Analysis of Food Security and Agricultural Credit Facilities in Nigeria. The Open Agriculture Journal, 12(1): 227–239. https://doi.org/10.2174/1874331501812010227

Salman, D., Tawfik, Y., Samy, M. & Artal-tur, A. (2017). A new marketing mix model to rescue the hospitality industry - Evidence from Egypt after the Arab Spring. Future Business Journal, 3(1): 47–69. https://doi.org/10.1016/j.fbj.2017.01.004

United States Department for Agriculture and Rural Development (USDA). (2000). Understanding Cooperatives: Agricultural Marketing Cooperatives.

Verma, V. K. & Jheeba, S. S. (2023). Role of Cooperative Marketing in Agricultural Produce. https://www.krishisandesh.com/role-cooperative-marketing-agricultural-produce/ Accessed in 4/4/2024.

Zuma, M. K., Kolanisi, U. & Modi, A. T. (2023). Smallholder farmers' willingness to adopt, cultivate and consume provitamin A biofortified maize in Kwazulu Natal, South Africa. African Journal of Food, Agriculture and Nutrition, 23(2): 22602–22623. https://doi.org/10.3390/ijerph15040805