



FACTORS INFLUENCING THE ADOPTION OF IMPROVED GROUNDNUT VARIETIES (IGVs) OF N2AFRICA PROJECT AMONG FARMERS IN BORNO STATE, NIGERIA

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ABSTRACT

The study examined the adoption of improved groundnut varieties (IGVs) in N2Africa project among farmers in Borno State, Nigeria. A multi stage sampling techniques was used in selecting 600 respondents. Data were collected using structured questionnaires and were analysed using descriptive and inferential statistics. The results reveal that majority (75.0%) of the respondents were male and 28.2% had secondary education with more than half (53.7%) being members of cooperatives. The respondents had an average age, household size and farming experience of 45 years, 8 persons and of 22 years respectively. Almost all (96.5%) of the respondents were aware of the IGVs. The major sources of information on IGVs were extension agents (89.5%), radio (88.3%), farmer groups (70.8%) and friends/fellow farmers (62.7%). The results of logit regression analysis revealed that membership association ($P < 0.05$), farm size $P < 0.01$ and sex ($P < 0.1$) significantly influenced the adoption of IGVs. The major constraints to the adoption of IGVs were high cost of improved groundnut varieties (98.2%), scarcity of the IGVs (94.8%), and inadequate capital (94.3%). The study concluded that adoption of IGVs was high in the study area and SAMNUT22 had the highest adoption rate. The study also concluded that sex, group membership and farm size were the factors affecting the likelihood of adoption of IGVs with sex and participation determining the intensity of adoption. In addition, the adoption of IGVs had improved groundnut farmers' productivity, income and expenditure. It is recommended that community seed production, farmer participation should be encouraged and promoted to facilitate easy access to IGVs by farmers, private sectors should be encouraged to invest in extension services and farmers should be encouraged to participate in savings and internal lending community in order to raise more capital and enjoy economy of scale.

Keywords: Improved, Groundnut, Varieties, N2africa Project

INTRODUCTION

In Nigeria, agriculture is important for achieving the developmental goals of alleviating poverty and ensuring food security. Stimulating agricultural growth, and thus reducing poverty and improving food security primarily depends on the adoption of agricultural technologies (Neglo *et al.*, 2021). Adoption of improved technologies is an important means to increase the productivity of smallholder farmers in Africa, there by fostering economic growth and improve wellbeing of millions of the poor households (Habtewold and Heshmati, 2023). Janssen and Swinnen (2019) and Abraham and Pingali (2020) suggested that to improve production through the adoption of improved technologies, it is important to understand the factors which determine adoption of improved technologies

Groundnuts (*Arachis hypogaea* L.), known as peanuts, earthnut or monkey nuts and groundnut is edible crop which can be eaten raw or processed into oil, cake or snack foods. It is a legume plant that is cultivated throughout the tropical, sub-tropical and the warm temperate climatic zones (Radhakrishnan *et al.*, 2022). Groundnut is a staple food and valuable cash crop for millions of households (Ojiewo *et al.*, 2020). However, China, India, Nigeria, the USA and Myanmar are the leading groundnut producing countries in the world. Nigeria is the largest groundnut producing country in West Africa, accounting for 51% of production in the zone and contributing about 10% of total global production and 39% to that of Africa (Ahmed *et al.*, 2020). In Borno state, groundnut is a



major cash crop for many households, accounting for 21% of rural cash earnings and is a major source of employment (Thawur *et al.*, 2021).

Research to improve groundnut varieties that are high yielding with a view to increase production, were initiated in different research institutes in Nigeria such as the Institute for Agricultural Research at Ahmadu Bello University Zaria (IAR), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and International Institute of Tropical Agriculture (IITA) Ibadan. These improved groundnut varieties were promoted by several projects such as, Promoting Sustainable Agriculture in Borno state (PROSAB), Tropical Legume II (TL II) and recently N2Africa in collaborations with Borno state Agricultural Development Programme (BOSADP). N2Africa is putting nitrogen fixation to work for smallholder farmers in Africa through enhancing yield of grain legumes and expanding the farm area cropped with legumes to improve income, food and nutrition security. It is a large scale, science-based “research-4-development” project funded by the Bill and Melinda Gates foundation with a vision of building sustainable, long-term partnerships to enable smallholder farmers benefit from symbiotic nitrogen-fixation by grain legumes. The project was implemented in 11 countries including Nigeria. In Nigeria it was implemented in four states Kaduna, Niger, Kwara, Kano and Southern Borno state where the security situation is relatively calm. The project focuses on cowpea, groundnut and soybean.

Until recently, most of the farmers producing groundnut relied on local seed varieties with low use of improved inputs. Groundnut yield in Borno state used to be low and range between 0.5 to 1.5 tones/hectare compare to its potentials of 2.5 tones/hectare (PROSAB,2020). The introduction of improved groundnut varieties to farmers will help boost yield, which is a major challenge faced by farmers. Groundnut is an important crop in Borno State. Its production is however, affected by many constraints. These include inadequate access to improved varieties and seeds, climate change, drought, poor soil fertility, and pest, diseases, limited access to credit, and insufficient use of agrochemical such as fertilizers, pesticides, herbicides etc. In an attempt to ensure continued groundnut production in the face of these challenges, improved groundnut varieties that have the capacity to withstand such challenges were developed and introduced into Borno State through PROSAB, TL II and N2Africa projects (Amaza, 2016). Prominent among the improved varieties promoted include SAMNUT 21, SAMNUT 22, SAMNUT 23 and SAMNUT 24. The projects built the capacity of farmers and extension agents to use improved groundnut varieties. Due to the existence of community-based seed producers and the increase in market for commodities like groundnut, adoption of improved groundnut varieties may have changed. Since 2023, no further empirical studies were undertaken in the project area to determine factors influencing the adoption of the improved groundnut varieties (IGVs), in the study area. This informed the need to conduct the study. The specific objectives of the study were to;

- i describe the socio-economic characteristics of respondents in the study area;
- ii describe the level of awareness and sources of information on improved groundnut varieties among the respondents;
- iii determine the factors influencing the adoption of improved groundnut varieties among the respondents;
- iv identify the constraints to the adoption of improved groundnut varieties among the respondents in the study area.

METHODOLOGY

The Study Area

The study was conducted in Borno State, Nigeria where the improved groundnut varieties (IGTs) were disseminated to farmers by International Institute of Tropical Agriculture, (IITA) through The Promoting Sustainable Agriculture in Borno State (PROSAB) project, Tropical Legumes (TL) II project, and N2Africa project in collaboration with Borno State Agricultural Development Program (BOSADP). The project was being undertaken in four selected local government areas, namely; Biu, Kwaya Kusar, Hawul and Bayo Local Government Areas. The study area (Fig.2) is located between latitudes 10° 30'N and 10° 45'N and longitude 12° 23'E and 13° 13'E. The study area has a population



of about 352,886 (NPC, 2022) with 2020 projected population estimate of about 704,468 based on 3.2% annual population growth rate. The study area covers an area of 6,874.2 km² (BOSADP, 2020).

The study area falls within Northern and Southern Guinea Savanna ecological zone of Borno State. The climate of the area can be described as having warm climate with the hottest period in March/April and the coldest period in December /January. The highest temperature is around 34°C in April while the coldest is around 17°C in December. The annual rainfall ranges between 900mm to 1200mm and lasting from May to October (Kamara and Amaza, 2022) while the soil type is sandy loam and clay loam (BOSADP, 2020). The vegetation consists of tall trees and thick shrubs. It is estimated that about 70 percent of the rural population of the area are engaged in agriculture and their farming practices are characterised by a variety of crop and livestock-based production systems (BOSADP, 2020). The dominant crops grown for home consumption and for local markets are maize, sorghum, cowpea, groundnuts, rice and recently soybean. Livestock species (that is small and large ruminants as well as poultry) are an integral part of the farming system and provide income and food to households.

Sampling Technique and Sample Size

Multi-stage sampling technique was used in selecting the respondents. In the first stage, The Southern Borno State was purposely selected where the improved groundnut varieties were promoted by the project. In the second stage, the four local government areas (LGAs) in Southern Borno were purposively selected as the only project implementation areas, these LGAs were: Bayo, Biu, Hawul and Kwaya-Kusar. In the third stage, thirty communities where IGVs are being promoted were systematically selected from the four LGAs. The basis for this selection is informed by the presence of registered households in the communities. The fourth stage involved a random and proportionate (5%) selection of 600 respondents from the study area. The list of groundnut farmers in the various communities was obtained from the service department of BOSADP. A total of six hundred respondents were selected and used as the sample size for the study.

Method of Data Collection and Analysis

Primary data were used for the study and were collected from the respondents using e-questionnaire. Trained enumerators under the supervision of the researcher were used to collect the data electronically using kobo-collect. Data for the study were analysed using descriptive and inferential statistics. The descriptive statistical such as means, frequency distribution and percentage were used to achieve objectives i, ii, and iv. Logit model was used to achieve objective iii which was to examine the likelihood of adoption of improved groundnut variety. The Logit model has been shown to be more precise and appropriate in analyzing the relationships involving binary dependent variable and a set of independent variables.

Theoretically, the Logit model is expressed as:

$$\mu = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + \dots B_nX_n \quad \dots (1)$$

Where:

μ = Likelihood of Adoption, otherwise labeled as ADOPT. It is quantified as:

Adopter = any farmer that devoted at least 10% of his/her land for groundnut production; and Non adopters = any farmer that devotes less than 10% of his/her land for groundnut production, (Ojiewo *et al.*, 2020).

B_0 = intercept;

$B_1 \dots B_n$ = estimated parameters;

$X_1 \dots X_n$ = Set of independent variables.

For the Logit Model, the equation for the relationship between socio-economic characteristics of respondents and the likelihood of adoption is specified as:

$$ADOPT = B_0 + B_1SEX + B_2EDU + B_3HHS + B_4FMS + B_5EXC + B_6GPM + e \quad \dots (2)$$

Where:

ADOPT = likelihood of adoption, Dummy variable (1 for adoption and 0 for non-adoption).

SEX = Gender of respondents (1 = male, 2 = female).

EDU = Educational level (measured in number of years spent in formal schooling).

HHS = Household size (measured in number of persons living under the care of the respondent).



FMS = Farm size (total area of land owned/operated by respondent measured in hectares).

EXC = Extension contacts (measured in number of contacts of groundnut farmer with extension agent).

GPM = Group membership (member =1, or non-membership = 0).

e = Error term which satisfies all the econometric conditions.

RESULTS AND DISCUSSION

Socioeconomic Characteristics of the Respondents

The results in Table 1 reveal that 36.0% of the respondents were above 50 years. While 26.8.0%, 17.0%, 15.0% and 4.7% fell within the age bracket of 34-41, 42-49, 26-33 and 18-25 years, respectively with an average age of 45 years. The average age of 45 years implies that middle-aged farmers are more actively engaged in groundnut production due to their physical strength, access to resources, and decision-making capacity and are likely the main adopters of improved varieties because they are more willing to take risks and experiment with new technologies compared to older farmers, who might be more resistant to change. Similar findings were reported by Adebayo *et al.* (2020) that middle aged farmers were the most active adopters of improved groundnut varieties in Northern Nigeria due to their willingness to embrace new technologies and their access to productive resources. Similarly, Musa *et al.* (2020) also reported that middle aged smallholder farmers in Zambia had the highest adoption rates of improved crop varieties, as they were more adaptable to new farming techniques compared to older farmers.



Table 1: Distribution of Respondents based on Socio-Economic Characteristics (n = 600)

Variable	Frequency	Percentage	Mean
Age (years)			
18-25	28	4.7	45
26-33	90	15.0	
34-41	161	26.8	
42-49	102	17.0	
> 50	219	36.5	
Sex			
Male	450	75.0	
Female	150	25.0	
Marital Status			
Married	302	50.3	
Single	108	18.0	
Widowed	148	24.7	
Divorced	42	7.0	
Household Size (number of persons)			
1-5	178	29.7	8
6-10	279	46.5	
11-15	110	18.3	
16-20	27	4.5	
21-25	6	1.0	
Education Level			
No formal education	163	27.2	
Adult education	28	4.7	
Primary education	115	19.2	
Junior Secondary	25	4.2	
Secondary education	169	28.2	
Tertiary education	100	16.7	
Farming Experience (years)			
2-10	118	19.7	22
11-18	123	20.5	
19-26	184	30.7	
27-34	78	13.0	
> 35	97	16.1	
Cooperatives membership			
Yes	321	53.5	
No	279	46.5	

Source: Field Survey, 2020.

The results also revealed that majority (75.0%) of the respondents were male and 25.0% were female. The result implies that male dominate farming population of the study area. This could be due to tradition and religious beliefs that women are only restricted to their compounds and perform domestic work for their families. The result is in line with the finding of Idrisa (2019) that in southern part of Borno State, male dominates farming activities. Similarly, Mbavai (2023) reported similar trend in a study of cowpea farmers in Musawa Local Government Area, Katsina States, Nigeria, where male dominates farming activities,

The results further showed that half (50.3%) of the respondents were married, 18.0% were single while 24.7% and 7.0% were widowed and divorced, respectively. This implied that the respondents tend to have more responsibilities and thus will be willing to continue using the new technologies to increase their production, secure the food needs of their household and earn more income. This is in line with Shehu *et al.* (2019) and Kadafur *et al.* (2017) that majority of farmers were married in North-eastern Nigeria.

The results revealed that 46.5%, had a household size between of 6–10 persons and 29.7%) had between 1–5 persons, Respondents with of 11–15 persons, 16–201.0%, and 21–25 persons



constitute 18.3%, 4.5%, and 1.0%, respectively with an average of 8 persons. Household size is important in agriculture as it determines the availability of labour for farm production, The result implies that there may be availability of labour for agricultural production.

The results further showed that 28.2% of the respondents had secondary education, respondents with primary education accounted for 19.2% while 27.2%, 16.7%, 4.7% and 4.2% had no formal education, tertiary education, adult education, and junior secondary education, respectively. This implies that respondents in the study area had a moderate level of formal education. The results aligned with the report of Aliyu *et al.* (2021) that education plays a role in enhancing farmers' ability to comprehend and adopt improved agricultural technologies. Similarly, Yusuf *et al.* (2022) reported that farmers with higher educational attainment were more likely to adopt improved maize varieties due to their better information processing and decision-making skills.

The results of farming experience of the respondents as indicated in Table 1 reveal that a reasonable proportion (30.7%) of the respondents had farming experience ranging between 19-26 years and 20.5% had 11-18 years, while 19.7%, 16.1%, and 13.0% had between 2-10 years above 35 years and 27-34 years of farming experience, respectively with an average of 22 years. It is expected that farmers with more years of experience may have acquired more resources or authority that may give them the courage and confidence to try new ideas. This is in line with the findings of Bamire *et al.*, (2019), that longer years of being exposed to farming could reduce farmers' uncertainty level in their production and may also likely enhance the probability of adopting new technologies.

The results from the Table further depicts the distribution of respondents based on membership of associations. More than half (53.7%) of the respondents were members of one cooperative or the other while 46.5% were non-members. Membership of association enables farmers to interact with other farmers, share their experiences and assist themselves. Hence, could leads to adoption of improved groundnut varieties in the area. The results agreed with Idiong *et al.* (2022) that membership of associations enabled women to acquire more land compared to those who were not members.

Respondents' Awareness and Source of Information on Improved Groundnut Varieties (IGVs)

As indicated in Table 2, almost all (96.5%) of the respondents were aware of the improved groundnut varieties. Only 3.4% of the respondents had no awareness on the IGVs in the study area. This could be attributed to the public private partnerships approach used by N2Africa project to reach out to more smallholder farmers in the study area. Awareness represents the knowledge of the innovation's existence. The results agreed with the report of Adebayo *et al.* (2020) that majority of the farmers in Kaduna State were aware of improved cowpea varieties.

Table 2: Distribution of the Respondents according to Level of Awareness of IGVs (n = 600)

Variable	No. respondents	Awareness (%)
Aware	579	96.5
Not Aware	21	3.4

Source: Field Survey, 2020

Respondents' Sources of Information on IGVs

Table 3 reveal that the major sources of information about IGVs were extension agents (89.5%), radio (88.3%), farmer groups (70.8%) and friends/fellow farmers (62.7%) which were ranked 1st, 2nd, 3rd and 4th respectively. Less than half (42.8% and 40.7%) of the respondents sourced information through agro-dealers and demonstration field school which were ranked 5th and 6th, respectively. Meanwhile, respondents that sourced information from television and via short messages services (SMS) constitute 33.5% and 30.8%, these were ranked 7th and 8th, respectively. This could be attributed to the frequent visits by the extension agents during the project implementation. This is in conformity with the findings of Ouma, *et al.* (2016) that the number of extension contacts positively influences the adoption of improved technology by farmers.

Table 3: Distribution of the Respondents According to Sources of Information on IGVs (n = 600)

Sources of information	Frequency	Percentage*	Rank
Extension agents	537	89.5	1 st
Radio	530	88.3	2 nd
Farmer group	425	70.8	3 rd
Friends and fellow farmers	376	62.7	4 th
Agro-dealer	257	42.8	5 th
Demo and field school	244	40.7	6 th
Television	201	33.5	7 th
Short message services (SMS)	185	30.8	8 th

Source: Field Survey, 2020

*Multiple response were recorded

Factors Affecting the Likelihood of Adoption of IGVs

The results in Table 4 revealed that membership in an association was found to be positive and significant ($P < 0.05$) toward influencing the adoption of IGVs. This implies that membership in an association will lead to an increase in adoption of IGVs. This result is similar to that reported by Moyo *et al.* (2021) that membership of organization or cooperative indicates the intensity of contacts with other farmers. Mbavai *et al.* (2019) and Adebayo *et al.* (2020) also reported that membership of an association was significant in influencing the adoption of improved cowpea varieties in Sudan Savannah of Northern Nigeria and soybean production among male and female farmers in Borno State respectively.

Table 4: Factors Influencing the Adoption of Improved Groundnut Varieties (IGVs)

Variable	Coef.	Std. Err.	z	P> z	dy/dx
Sex	-0.45	0.27	-1.67	0.09*	-0.11063
Education Level	0.08	0.07	1.16	0.25	0.02065
Group Membership	0.05	0.02	2.01	0.04**	0.01228
Household Size	0.01	0.03	0.22	0.83	0.00149
Extension Contact	4.19e-07	4.13e-07	1.01	0.31	1.04e-07
Farm Size	0.51	0.15	3.31	0.00***	0.12700
Constant	-0.42	0.32	-1.34	0.18	
LR chi2(6)	21.2				
Prob > chi2	0.0017				
Pseudo R Square	0.039				
Log likelihood	-264.54726				

Source: Field Survey, 2020

*** significant 1%,

** significant 5%

The results also revealed that the estimated coefficient of sex was negative and significant ($P < 0.1$) in influencing the groundnut farmers' decision to adopt IGVs in the study area. This implies that the likelihood of adoption of IGVs is higher amongst female farmers than male farmers and this could be attributed to the fact that females are more into legume production than their male counterpart in the project area. The results disagreed with the report of Taru *et al.* (2020) that female farmers were more likely to adopt natural resources management and conservation practices compared to their male counterparts. This could be due to keen interest female farmers having on natural resources conservation.

The results further revealed that the estimated coefficient of farm size was positive and significant at ($P < 0.01$) in influencing the groundnut farmers' decision to adopt IGVs in the study area. Farmers with larger farms will be more willing to devote portion of the land to an untried variety compared to those with smaller farms. This is because the larger the farm size cultivated the higher the tendency to adopt. Therefore, farm is expected to have a positive impact on adoption. The finding corresponds with that of Owolabi *et al.* (2021) and Aker, (2021). Abdullahi *et al.* (2020) that, the positive and significant coefficient of farm size indicates its positive influence on participation in technology adoption.



Constraints to Adoption of Improved Groundnut Varieties

Table 5 revealed that high cost of improved groundnut varieties (98.2%), scarcity of the IGVs (94.8%), and inadequate capital (94.3%) ranking 1st, 2nd, and 3rd, respectively were the major constraints to the adoption of improved groundnut varieties in the study area. The results also reveal that, land ownership and inadequate technical know-how which were ranked 4th and 5th were also reported by 75.8% and 70.0% of the respondents, respectively. The cost of IGVs is a primary barrier to adoption. Farmers, often operating with limited financial resources, find it challenging to invest in these expensive seeds, which discourages adoption and perpetuates reliance on lower-yielding traditional varieties. Limited availability of IGVs further constrains adoption. This agreed with the report of Dersseh *et al.* (2016) that high cost of improved varieties is one of the constraints to adoption of potato farming system in Chenchu, Ethiopia. Also, Gyasi *et al.*, (2023) discovered that inadequate improved seeds and capital were the major constraints to the adoption of early maturing maize varieties in Northern Ghana.

Insecure land tenure and limited access to arable land discourage farmers from adopting IGVs. This agreed with Taru *et al.* (2020) that the technical skills of farmers affect the adoption of improved technologies in Northwest Nigeria. Farmers with access to well-trained extension personnel were more likely to adopt improved varieties, highlighting the importance of technical knowledge in the adoption process. Similarly, Mwalongo *et al.* (2020) described land ownership as a factor influencing the adoption of improved groundnut cultivars in Tanzania. Secure land tenure provided farmers with the confidence to invest in new agricultural technologies, including IGVs.

Table 5: Constraints to Adoption of Improved Groundnut Varieties

Community	Frequency	Percentage*	Ranking
High cost of improved seed varieties	589	98.2	1 st
Scarcity of improved seed varieties	569	94.8	2 nd
Inadequate capital	566	94.3	3 rd
Land ownership	455	75.8	4 th
Inadequate technical know how	420	70.0	5 th

Source: Field Survey, 2020

*Multiple responses were recorded

CONCLUSION AND RECOMMENDATION

The study concluded that the adoption of IGVs was high in the study area and SAMNUT22 had the highest adoption rate. The study also concluded that sex, group membership and farm size were the factors affecting the likelihood of adoption of IGVs. Based on the findings of this study, the following recommendations were made:

- Community seed production should be encouraged and promoted to facilitate easy access to improved seeds by farmers.
- The projects implementers should be encouraged to use participatory research and extension approach in implementing projects.
- Development of policy which provides adequately involvement of farmers in any developmental and research project, has the potential of raising adoption to a higher level.
- Smallholder farmers should be encouraged to participate in savings and internal lending community (SILC) schemes in their various communities
- Extension services are of paramount in dissemination of innovations to farmers therefore, private sectors should be encouraged to invest in extension services.

REFERENCES

- Abdullahi, A. A., Yusuf, M. S., and Bala, I. K. (2020). Constraints to the adoption of improved groundnut varieties and their impact on productivity among smallholder farmers in Nigeria. *African Journal of Agricultural Research*, 15(9): 1273-1281.
- Abraham, M., and Pingali, P. (2020). Transforming smallholder agriculture to achieve the SDGs. *The role of smallholder farms in food and nutrition security*, Pp. 173-209.



- Adebayo, G., (2020). Adoption and impact assessment of improved groundnut varieties on poverty using DNA-Fingerprinting data: Evidence from smallholder rural farmers in Northern Nigeria. 97th Annual Conference, March 27-29, 2023, Warwick University, Coventry, UK 334554, Agricultural Economics Society - AES.
- Ahmed, B., Echekwu, C. A., Mohammed, S. G., Ojiewo, C., Ajeigbe, H., Vabi, M. B., Affognon, H., Lokossou, J., and Nwahia, O. C. (2020). Analysis of Adoption of Improved Groundnut Varieties in the Tropical Legume Project (TL III) States in Nigeria. *Agricultural Sciences*, **11**(2): 143–156.
- Aker, J. C. (2021). Dial “A” for agriculture: A review of information and communication technologies for agricultural extension in developing countries. *Agricultural Economics*, **42**(6): 631-647.
- Aliyu, A. M., Abdullahi, Y. A., and Musa, A. I. (2021). Influence of Farmers’ Education on Adoption of Improved Agricultural Practices in Northern Nigeria. *Journal of Agricultural Extension*, **25**(3): 45–56.
- Amaza P, Kwacha A, Kamara, A. (2022). Farmers’ perceptions, profitability, and factors influencing the adoption of improved maize varieties in the Guinea Savannas of Nigeria. IITA: Research to nourish Africa.
- Bamire S. A., Abdoulaye T., Amaza P., Tegbaru A. Alene, A. D. and Kamara, A. Y. (2019). Impact of promoting sustainable Agriculture in Borno (PROSAB) Program adoption of improved crop varieties in Borno State of Nigeria. *Journal of food, agriculture and Environment*, **8** (3and4): 391-398.
- Borno State Agriculture Development Programme (BOSADP) (2021). Diary Maiduguri.
- Dersseh, W. M., Gebresilase, Y. T., Schulte, R. P., and Struik, P. C. (2016). The analysis of potato farming systems in Chench, Ethiopia: input, output and constraints. *American Journal of Potato Research*, **93**(5): 436-447.
- Habtewold, T. M., and Heshmati, A. (2023). Impacts of improved agricultural technology adoption on welfare in Africa: A meta-analysis. *Heliyon*, **9**(7): 85-92.
- Idiong, C. I., Agom, D. I. and Ohen, S. B. (2022). Comparative Analysis of Technical Efficiency in Swamp Rice and Upland Rice Production Systems in Cross River State Nigeria: Proceedings of Farm Management Association of Nigeria from 18-21 September 2022
- Idrisa, Y. L. (2019). Analysis of the Determinant of Soybean Production Technology Adoption by Farmers in Southern Borno, Nigeria. Unpublished Ph. D. Thesis submitted to the Department of Agricultural Economics and Extension Services, University of Maiduguri, Nigeria
- Janssen, E., and Swinnen, J. (2019). Technology adoption and value chains in developing countries: Evidence from dairy in India. *Food policy*, **83**: 327-336.
- Kadafur, I. M., Idrisa, Y. L., and Shehu, A. (2017). Adoption of improved maize varieties in Northern Guinea Savannah of Borno State, Nigeria. *Journal of Agricultural Extension*, **24**(1): 34-41.
- Kamara, A. Y. and Amaza, P. S. (2022). Participatory on-Farm Evaluation of the Performance of Drought- Tolerant Maize Varieties in the Guinea Savanna of Nigeria. *Journal of Food Agriculture and Environment*. **1**(1): 192-196.
- Mbavai, J. J., Shitu, M. B., Abdoulaye, T., Oyinbo, O., and Kamara, A. Y. (2019). Factors influencing the adoption of improved cowpea varieties in the Sudan Savannas of Northern Nigeria. *Journal of Agricultural Extension and Rural Development*, **11**(11): 200-207.
- Moyo, T., and Others. (2021). Variations to climate change adaptability of groundnut varieties in East Africa. In W. Leal Filho (Ed.): *Handbook of Climate Change Resilience* (pp. 1-15). Springer.
- Musa, Y. H., Vosanka, I. P., Inuwa, A. and Mohammed, S. (2019). Economic Analysis of Cowpea Production in Donga Local Government Area of Taraba State, Nigeria. *Journal of Sciences and Multidisciplinary Research*. **2**: 2-16.
- Mwalongo, S., Akpo, E., Lukurugu, G. A., Muricho, G., Vernoooy, R., Minja, A., ... and Varshney, R. (2020). Factors influencing preferences and adoption of improved groundnut varieties among farmers in Tanzania. *Agronomy*, **10**(9): 12-21
- Neglo, K. A. W., Gebrekidan, T., and Lyu, K. (2021). The Role of agriculture and non-farm economy in addressing food insecurity in Ethiopia: a review. *Sustainability*, **13**(7): 38-44.



- Ojiewo, C. O., Janila, P., Bhatnagar-Mathur, P., Pandey, M. K., Desmae, H., Okori, P., and Varshney, R. K. (2020). Advances in crop improvement and delivery research for nutritional quality and health benefits of groundnut (*Arachis hypogaea* L.). *Frontiers in Plant Science*, **11**: 29-35.
- Ouma, J. O., Murithi, F. M., Mwangi, W., Verkuijl, H., and Gethi, M. (2016). Adoption of improved maize seed and fertilizer use in Embu District, Kenya. International Maize and Wheat Improvement Center (CIMMYT).
- Owolabi, J. O., Sani, M. H., and Mohammed, L. A. (2021). Impact of improved groundnut varieties on productivity and income of smallholder farmers in Northern Nigeria. *Journal of Agricultural and Rural Development*, **10**(2): 98-112.
- PROSAB 2020). Promoting Sustainable Agriculture in Borno State. Synthesis Livelihood Analysis in Three Contrasting Agro-ecological Zones, PROSAB, Borno State, Nigeria, pp. 1–45.
- Radhakrishnan, T., Kona, P., Ajay, B. C., and Kumar, N. (2022). Groundnut Breeding. In *Fundamentals of Field Crop Breeding* (pp. 837-906). Singapore: Springer Nature Singapore.
- Shehu, A., Idrisa, Y. L., Abdoulaye, T., Murtala, N. and Baributsa, D. (2019). *Effect of Social Capital on Purdue Improved Cowpea Storage Technology Use in North-East Nigeria*. Presented at 24th Agricultural Extension Society of Nigeria, Abuja. Book of Abstract. Pp.cxvi-cxvii.
- Taru, V. B., Kyagya, I. Z., and Mshelia, S. I. (2020). Profitability of groundnut production in Michika Local Government Area of Adamawa State, Nigeria. *African Journal of Agricultural Research*, **5**(21): 2824-2830.
- Thawur, P., Hadiza, S. Nuhu, Yusuf, L. Idrisa, and Adamu A. Gadzama. (2021). Factors Influencing Adoption of Improved Groundnut Varieties among Women Farmers in Southern Part of Borno State, Nigeria. *Journal of Agricultural Economics, Environment and Social Sciences*, **7**(1): 89-103.
- Yusuf, I. B., Umar, F. S., and Jibrin, M. (2022). Educational status and adoption of improved maize varieties in Kano State, Nigeria. *International Journal of Agricultural Economics and Extension*, **10**(1): 33–40.