EFFICIENCY OF WHEAT PRODUCTION BASED ON OUTGROWER SUPPORT MODEL AMONG FARMING HOUSEHOLDS IN JIGAWA AND KANO STATE, NIGERIA

ADEKEYE MOJISOLA DEBORAH
Department of Agricultural Development and Management (ADEM),
Agricultural and Rural Management Training Institute (ARMTI), Ilorin, Kwara State, Nigeria
Email; adekeyejisola@gmail.com; +2348033825759

MUHAMMAD-LAWAL, ABDULAZEEZ
Department of Agricultural Economics & Farm Management,
University of Ilorin, Kwara State Nigeria
Email; lawalazeez@unilorin.edu.ng; +2348035622384

***IYIOLA OLUMIDE AYOBAMI**
Department of Rural Development and Gender Issues (RUDEG),
Agricultural and Rural Management Training Institute (ARMTI), Ilorin, Kwara State, Nigeria
Email; ayoolu099@gmail.com; +2348063469324

OWOLABI, MARVELLOUS TEMILOLUWA
Department of Agricultural Development and Management (ADEM),
Agricultural and Rural Management Training Institute (ARMTI), Ilorin, Kwara State, Nigeria
Email; marvydelight@gmail.com; +2347063217183

ABSTRACT
This study examines the significant difference in the efficiency of wheat production among various out-growers support models in Kano and Jigawa States, Nigeria. Using primary data from 473 respondents, the study employs Stochastic Frontier Analysis (SFA) to measure technical efficiency and ANOVA to assess significant differences among the support models. The findings reveal that 81.61% of farmers participate in out-grower schemes, with the Market-Input Credit-Technical Assistance (MITa) model achieving the highest efficiency (65.84%). While guarantee market access improves efficiency, land provision without complementary support is inadequate. The study concludes that a holistic support framework, integrating market access, input provision, and technical assistance, is essential for optimizing wheat production efficiency. The study recommends MITA Model for enhanced access to financial resources, technical training, extension services and guaranteed market to strengthen smallholder farmers' capacity and efficiency of food production.
Keywords: Efficiency, Wheat Production, Out-grower Model, Stochastic Frontier Analysis, ANOVA.
JEL Codes: Q12, Q13, D24, O13

1. INTRODUCTION
Wheat (Triticum aestivum L.) belongs to the tribe Triticeae, one of the largest and most significant tribes in the Poaceae family (Laugerotte, 2022). The cultivation of wheat dates back approximately 7,000 years in Western Asia and gradually spread to nearly all regions of the world. Today, wheat is grown on 217 million hectares globally, producing 712 million metric tons annually (Erenstein et al, 2022). Wheat production is a critical component of Nigeria's agricultural sector, yet domestic supply remains insufficient to meet national demand. Domestic wheat production in Nigeria stands at an average yield of 1.2T/ha meeting less than 0.01% of the country's consumption needs Despite government interventions, including protectionist policies and out-grower schemes, Nigeria continues to rely heavily on wheat imports, which strain the country's foreign exchange reserves (NBS, 2024; FAOSTAT, 2021). Wheat, a staple used in producing bread, pasta, and other essential food products, is primarily

grown in the northern region, with Kano and Jigawa States being the leading producers in Nigeria. However, smallholder farmers, who dominate wheat production, face significant challenges, including limited access to credit, modern inputs, and technical support (Swinnen & Kuijpers, 2020). To ensure sustainable wheat production in Nigeria, the Nigerian government has implemented several interventions, including adopting protectionist policies to control commercial grain imports. Governments, corporate agribusinesses, and global development institutions advocate integrating smallholders into out-grower schemes to enhance wheat value chains. Out-grower schemes, interchangeably used as contract farming, are binding arrangements where a firm ensures its production capacity, is met by individual farmers or farmer groups (Adekeye, 2018; Bellemare & Bloem, 2018). This Integration is a strategy for providing support as incentives to motivate farmers through providing inputs, technical assistance, and guaranteed markets, although with diverse processes and local dynamics (Manda et al, 2020). Although out-grower schemes aim to address production challenge, their effectiveness varies, and little is known about which support model yield the highest efficiency. Understanding the impact of these variations is essential for optimizing wheat production and reducing Nigeria's dependence on imports. Therefore, this study assesses the efficiency of wheat production under different out-grower support models among farming households in Kano and Jigawa States, Nigeria. Specifically, the study examines the socioeconomic characteristics of wheat farming households; identify the different out-grower support models available to farmers; and assesses significant efficiency differences across available support models.

2. LITERATURE REVIEW

The Role of Out-grower Support to Wheat Production

With the global population projected to reach 9 billion by 2025 and the continuous deterioration and loss of agricultural lands (Lam & Leibbrandt, 2023), developing higher-yielding and high-quality crop varieties has become imperative to meet the food demands of billions of people. Hence, out-grower scheme presents itself as a viable strategy for sustainable wheat production. According to United Nations Food and Agricultural Organization (FAO, 2018), out grower schemes can help smallholder farmers overcome production constraints, such as financial constraints, poor access to inputs, or lack of technical and managerial capacity, or assure a market for their harvests (Barrett *et al*., 2019). Also, an out-grower scheme can enhance investors' access to land, labour, quality produce, and improve investor-community relations, thereby creating possibly a win–win strategy especially in developing countries where there are multiple and interdependent constraining factors to productivity and efficiency (FAO 2022; Maertens & Velde, 2017; African Union 2014).

This study therefore adopts contract farming theory using a basic principal-agent model to show how optimal and diverse support carefully weighs risks against incentives. The model shows how contracting links the principal's support to improved production efficiency (Ivanov, 2024). To understand the efficiency variations in wheat farming and its relationship between input use and output production, providing insights into how resources are optimized for maximum yield and profitability, especially within the context of out-growers, production economics theory was adopted. The theory encompasses the concept of production function, which describes the relationship between input usage and the resulting output, often expressed mathematically as $Q = f(L, K)$, where Q represents output, and L and K represent labour and capital inputs, respectively. This function helps in understanding how changes in input levels can influence output, enabling producers to make informed decisions about resource allocation (Durham & Mizik, 2021).

Empirically, Oloyede *et al.,* (2022) highlighted that out-grower schemes in Northern Nigeria have led to increased wheat yields due to better access to quality inputs and improved farming

practices. The study found that participating farmers experienced an average yield increase of 30% compared to non-participants. This boost in productivity is attributed to the provision of certified seeds, fertilizers, and pesticides by agribusiness firms, along with training on modern agronomic practices.

Poku *et al.*, 2018 similarly employed a comparative case study approach of a public and private cassava out-grower scheme in Ghana and suggested that firms' capacity and commitment to design contracts with embedded support services for out-growers is essential to smallholder participation and efficiency of out-growers' arrangements.

Furthermore, Abegunde (2021) assessment of out-grower scheme effectiveness for cassava enterprise using a three-stage sampling procedure shows that the effectiveness of cassava out-grower scheme was enhanced by extension provision, guaranteed market, input access, perceived change in productivity and conformity to scheme agreements.

However, little or no research focused specifically on comparing different types of out-growers supports available to farmers and their effect on the efficiency of wheat. Hence, this study adopts the concept of assessing the relationship between the efficiency of production and various support mechanisms available to wheat farming households.

The null hypothesis states that there is no relationship between the efficiency of production of the farmers and the support model of the farmers.

3. METHODOLOGY

The study was conducted in Kano and Jigawa States, the two largest wheat-producing States accounting for 70% of the country's total wheat production (NBS, 2021). Data were collected from 10 communities across the two agro-ecological zones in the two states, involving 400 wheat growers and 100 non-growers through a structured questionnaire and interview schedule. A four-stage random sampling technique was employed using KoboTool digital software. The first stage involved the random selection of two (2) Local Government areas (LGA) from Jigawa State and three (3) Local Government areas (LGA) from Kano State. The second stage involved random sampling of 2 communities from each Local Government Area and fourth stage involved selection of 40 wheat out-growers and 10 non-growers per community, totalling 500 farming households**,** of which 473 responses were deemed valid for analysis.

Analytical Techniques

Descriptive statistics were used to analyse the socioeconomic characteristics, farming practices, and participation in out-grower schemes among wheat farming households. Concencation was used to describe combination of different supports available to wheat farmers. Supports available includes Guaranteed Market (Contractual agreement), Technical Assistance (Training access & Extension access), Land, Input Credit. Hence, the combinations of different types of support available represents the existing support models amongst the farming households. Stochastic Frontier Analysis (SFA) measured production efficiency across different out-grower support models. ANOVA was employed to assess significant differences in efficiency among these models. The study examined various support models, including the Market (Mrkt), Market-Input Credit (MI), Market-Land (MLa), Market-Technical Assistance (MTa), Market-Input Credit-Technical Assistance (MITA), Market-Land-Technical Assistance (MLTa), and Market-Input Credit-Land-Technical Assistance (MILTa) models. However, only the Mrkt, MLa, MTa, and MITA models were prominent, with others being statistically insignificant and therefore omitted from in-depth analysis. In conducting AVOVA test, the Bartlett's test was conducted as a preliminary step to determine if the variances across multiple groups are equal for analysis of efficiency by support models (Khan, 2024) The Bonferroni method was used for post hoc pairwise comparisons to evaluate differences in

efficiency between pairs of support models to adjust for controlling Type I error (Liu & Xu, 2022).

Model Specification

In estimating the efficiency level and factors that affect the efficiency of the production of the farmers, Stochastic Production Frontier model for technical efficiency put forward within the framework of Cobb Douglas production function was used (Gyong *et al.*, 2022)

Production Model: It is modelled as follows;

$Y_i = f(X_{ij};B).\ e(V_i)$ (i = 1,2,3….) n

Where:

Y_i is the output for the $_i$th observation

X_i is a vector of inputs (e.g. seed, labour irrigation)

B is a vector of parameters that was estimated

V_j is the random error term which captures the noise in the output that is not attributed to inefficiency.

4. RESULTS AND DISCUSSION OF FINDINGS

Descriptive Result

Table 1: Socio economic Characteristics of the Respondents

Characteristics	Frequency	Percentage	Mean
Age (Years)			
≤20	11	2.33	
21-30	129	27.27	
31-40	173	36.58	39.36
41-50	86	18.18	
51-60	46	9.73	
>60	28	5.92	
Gender			
Female	8	1.69	
Male	465	98.31	
Total	473	100.0	
Marital Status			
Single	89	18.82	
Married	383	80.97	
Others	1	0.21	
Education			
No Formal Education	115	24.31	
Primary	126	26.64	
Secondary	111	23.47	
NCE/Grade 2	71	15.01	
Diploma	31	6.55	
Bachelor Degree	18	3.81	
Postgraduate	1	0.21	
Farming Experience (Years)			
< 10	170	35.9408	
11-20	165	34.88372	18.39
21 -30	83	17.54757	
31 -40	35	7.399577	
41 -50	13	2.748414	
> 50	7	1.479915	
Household size			
≤ 5	316	66.80761	5
6 – 10	130	27.48414	

11 – 15	15	3.171247	
Farm Size (Ha)			
≤1.0	268	56.66	
1.1 - 2.0	161	34.04	1.40
>2.0	44	9.30	
Total	473	100	
Minimum	0.25		
Maximum	6		

Source: Field Survey, 2024

The study presented in Table 1 reveals that the majority of wheat farmers in Kano and Jigawa States are young to middle-aged, with a mean age of 39.36 years, reflecting an active agricultural workforce. This aligns with Lindsjo *et al.* (2021), who found that younger adults dominate rural farming due to their physical ability and economic necessity. The gender distribution shows a significant male dominance (98.31%), which is typical in agriculture, as Dzanku *et al.* (2015) noted that men primarily engage in crop production while women play less visible roles. Additionally, 80.97% of respondents are married, emphasizing the role of family structure in farming, a finding consistent with Olawuyi and Mushunje (2019). Education levels are generally low, with 24.31% having no formal education, limiting farmers' access to modern agricultural knowledge, as reported by Ojo *et al.* (2021). The average farming experience is 18.39 years, with a wide range of experience levels, reflecting trends observed by Ochieng *et al.* (2020) regarding productivity and decision-making in rural farming. The study also highlights that 56.66% of farmers operate on farms smaller than one hectare, reinforcing the predominance of small-scale farming, which is a common challenge in rural agriculture (Mburu *et al.*, 2022). This implies that wheat production in the study area is largely dependent on smallholder farmers with limited access to land and formal education, which may hinder productivity and efficiency.

Table 2: Socio Economic Characteristics of Respondent

Variables	Frequency	Percentage
No of plots		
1	473	100
Land Tenure System		
Association land	1	0.21
Community Land	10	2.11
Company land	42	8.88
Family Inheritance	214	45.24
Lease	106	22.41
Personally acquired	100	21.14
Crop Diversification		
None	93	19.66
2	315	66.6
3	65	13.74
Types of Crops Grown		
Wheat	93	19.66
Wheat; Maize	84	17.76
Wheat; Millet	8	1.69
Wheat; Rice	216	45.67
Wheat; Sorghum	3	0.63
Wheat; Tomatoes	4	0.85
Wheat; Maize; Millet	40	8.46
Wheat; Maize; Rice	21	4.44
Wheat; Rice; Beans	1	0.21

Wheat; Rice; Sorghum	3	0.63
Wheat Output		
1001 – 2000	102	21.56448
2001 – 3000	141	29.80973
3001 – 4000	143	30.23256
4001 – 5000	17	3.59408
>5000	38	8.033827
Credit Access		
Yes	94	19.88
No	379	80.12
Access to Training		
Yes	86	18.19
No	387	81.81
Number of Extension Visits		
Nil	368	77.80
1-2	63	13.32
3-4	34	7.19
>4	8	1.69

Source: Field Survey, 2024

The result presented in Table 2 shows that all 473 respondents reported owning only one plot of land, suggesting cultural or economic factors that discourage land fragmentation. The most common form of land acquisition is family inheritance (45.24%), indicating a strong tradition of generational land transfer, which influences farming practices and socio-economic stability. Most farmers (60%) produce between 2000 and 4000kg of wheat, with only 8% exceeding 5000kg, suggesting moderate productivity levels, similar to Meemken & Bellemare (2020), who found that farmers with improved input access and market support tend to achieve mid-level production. Additionally, credit access remains low (19.88%), consistent with Khan, *et al.* 2024 & Bashir *et al.* (2020), who identified inadequate agricultural finance as a key constraint for wheat farmers. Furthermore, 77.80% of farmers have no extension service visits, and only 18.19% receive training, despite 81.60% participating in out-grower schemes.

Out-grower Support Models of the Wheat-Farming Households

This section presents the out-grower status, as well as the support models and level of support accessed by the respondents.

Table 3: Distribution of the Respondents according to issues related to support received

Issues	Frequency	Percent
Out-grower status		
Non-out-grower	87	18.39
Out-grower	386	81.61
Out-growers Support Models		
Market (Mrkt) Model	171	44.30
Market; Land (MLa) Model	52	13.47
Market; Input/Credit (MIc) Model	16	4.15
Market; Technical assistance (MTa) Model	54	13.99
Market; Input/Credit ;Technical assistance (*MITA*) Model	89	23.06
Market; Land; Technical Assistance (MLTa) Model	3	0.7
Market; Land ; Input/Credit ; Technical Assistance (MILTA) Model	4	1.04

Source: Field Survey, 2024

Table 3 reveals that amongst the out-growers, guaranteed market is the most common form of assistance, with 44.30% of farmers relying solely on this support which is the major

requirement for them to participate in any out-grower scheme (Hoang & Nguyen, 2023). Additionally, 23.06% of farmers receive a combination of market access, inputs or credit, and technical assistance, reflecting a fuller support package that address both production and market challenges, i.e. Market; Input/Credit; Technical Assistance (MITa) Model. The fact that nearly one-fifth of the farmers are in this category implies that there is a considerable demand for combined support systems. However, the result shows that fully combined support models are rare, possibly due to the higher costs involved in providing such complete assistance as noted by Gani *et al.*, 2023.

Efficiency of Wheat Production of the Respondents

The efficiency of production estimate on table 4 shows the level of efficiency amongst the wheat-farming households using stochastic frontier analysis.

Table 4: Level of efficiency of Wheat Production amongst the Respondents

Efficiency (%)	Frequency	Percentage
<20	17	3.59
20.0 – 39.99	18	3.81
40.0 – 59.99	108	22.83
60.0 – 79.9	281	59.41
>80	49	10.36

Source; Data analysis 2024.

The result in Table 4 shows that the majority of farmers (59.41%) have an efficiency score between 60.0 and 79.9%, showing that they are performing relatively efficiently given their inputs. A small proportion (10.36%) have efficiency scores above 80%, while 22.83% are between 40.0 and 59.99%. There is also a low proportion of farmers with extreme inefficiency (<20%). This corroborates FAO 2021 which suggests that efficient resource use and technology adoption can significantly boost production efficiency among farmers.

Efficiency of Wheat Production based on the out-grower support models

This section provides efficiency of various support models by the out-grower, presenting key statistical measures for each model.

Table 5: Efficiency of wheat farmers based on their out-grower support models

Support Models Efficiency	Observations	Mean	Minimum	Maximum
Non-out-grower	87	62.94247	8.12690	84.32891
Market	171	64.96216	8.28383	93.52589
ML	49	56.99924	15.8323	87.4523
MTa	54	65.26374	38.56156	94.20583
MITa	89	65.84419	23.49183	90.28329

Source; Data analysis 2024

The result presented in Table 4 shows that the highest mean efficiency, at 65.84%, is observed in the market, Inputs, and Technical Assistance (*MITa*) model. These findings suggest that out-grower schemes that provide comprehensive forms of support tend to improve technical

efficiency. Although the non-out-grower has a mean efficiency of 62.94%, they rely on personal resources, informal networks, and experience, which may help them maintain moderate efficiency levels but they might lack the structured support provided by out-grower schemes, such as guaranteed markets and technical assistance. In the context of developing countries, studies FAO 2018 have found that farmers outside formal support schemes tend to exhibit substantial variability in efficiency due to these factors.

Comparative analysis of the Efficiency of Wheat Production based on the out-grower support models

This section presents the comparative analysis of the efficiency of wheat production based on the out-grower support models.

Table 6: Significant Differences in Efficiency of Production of the support models

Row Mean-Col Mean	**MI**	*MITA*	ML	MTa
MITa	6.697061			
ML	2.14831	-8.84536 0.035		
MTa	6.11721	-0.57986 1	8.2655 0.18	
Mrkt	5.815291	-0.88177 1	7.96359 0.04	-0.30191 1
Nil	3.795771	-2.90129 1	5.94407 0.846	-2.32143 1

Source; Data analysis 2024

The result presented in Table 6 shows that there is a significant difference between *MITa* vs ML ($p = 0.035$). The significance level shows that the *MITa* model is statistically better in terms of efficiency. Also, there is a significant difference between Market vs ML ($p = 0.040$) indicating that market access alone improves efficiency compared to market and land support. The result points to the inadequacy of land support as a strategy for improving agricultural efficiency. Thus, comprehensive support systems are essential for smallholder farmers to improve their efficiency as noted by Onyango et al, 2021. Also, Kassie *et al.* (2011) found that combining inputs such as fertilizers and seeds with training or technical advice leads to more efficient resource use amongst farmers in Ethiopia. However, the negative performance of the ML model can be explained by the complexities of land management. Farmers who receive land without additional support (such as inputs, technical assistance, or financial resources) might struggle to utilize it efficiently. Studies have shown that merely increasing access to land does not guarantee improved productivity or efficiency unless farmers have the means and knowledge to manage the additional land (Duncan *et al*, 2021).

5. CONCLUSION AND RECOMMENDATIONS

The study concludes that out-grower support significantly influences the efficiency of wheat production among farming households in Kano and Jigawa States, Nigeria. Among the different models analysed, the Market-Input Credit-Technical Assistance (MITa) model proved to be the most effective, yielding the highest mean efficiency of 65.84%. The findings reveal that while guaranteed market access is the most common form of support, efficiency improves when combined with input provision and technical assistance. However, models relying solely on land provision without complementary support were found to be inadequate in enhancing efficiency of production. Overall, 81.61% of farmers participate in out-grower schemes, yet access to credit and extension services remains limited, constraining further efficiency improvements. To optimize wheat production and support smallholder farmers, the study therefore recommends a holistic approach that integrates market access, input provision, and technical assistance without necessary taking them away from their land or supporting them with land for wheat production.

REFERENCES

Abegunde, B. O. (2021). Effectiveness of Out-grower Scheme among Cassava Farmers in

Adebayo, A. O., & Fashola, O. (2018). Economic analysis of wheat production in Nigeria.

Adekeye, Mojisola D (2018). "Assessment of Out-grower Scheme on Efficiency of Sugarcane Production in Oyo State, Nigeria. "*A Masters Dissertation Submitted to the Department of Agricultural Economics and Farm Management, Faculty of Agriculture, University of Ilorin, Ilorin, Nigeria.*

African Union Commission (2014). "Malabo Declaration on Accelerated Growth and Transformation for Shared Prosperity and Improved Livelihoods. "Paper presented at the 23rd Ordinary Session of the African Union, June 30, 2014, Malabo, Equatorial Guinea.

Barik, P., Bedamatta, R., & Vikraman, S. (2024). Smallholders in contract farming value chain: Challenges and opportunities, empirical evidence from West Bengal, India. *Journal of International Food & Agribusiness Marketing*, 1-33.

Bashir, M.K., Y. Mehmood and S. Hassan. 2020. "Impact of Agriculture Credit on Productivity of Wheat Crop: Evidence from Lahore, Punjab, Pakistan." Pakistan Journal of Agriculture Sciences Vol. 47, no.4, pp.405- 409.

Bellemare, M. F., & Bloem, J. R. (2018). Does contract farming improve welfare? A review. *World Development, 112, 259–271*. https://doi.org/10.1016/j.worlddev.2018.08.018

Duncan, E., Abdulai, A. R., & Fraser, E. D. (2021). Modernizing agriculture through digital technologies: Prospects and challenges. *Handbook on the human impact of agriculture*, 138-161.

Durham, T. C., & Mizik, T. (2021). Comparative economics of conventional, organic, and alternative agricultural production systems. *Economies*, *9*(2), 64.

Dzanku, F. M., et al. (2015). Gender, crop production, and household welfare in Ghana. Agricultural Economics.

Erenstein, O., Jaleta, M., Mottaleb, K. A., Sonder, K., Donovan, J., & Braun, H. J. (2022). Global trends in wheat production, consumption and trade. In Wheat improvement: food security in a changing climate (pp. 47-66). Cham: *Springer International Publishing.*

FAO. (2018). "The State of Food and Agriculture: Improving the Livelihoods of Smallholder Farmers."

FAOSTAT (2021) Food and Agriculture Organization of the United Nations. https://www.fao.org/faostat/en/. Accessed 29 Apr 2024

Ferrari, A., Bacco, M., Gaber, K., Jedlitschka, A., Hess, S., Kaipainen, J., Koltsida, P., Toli, E., & Brunori, G. (2022). Drivers, barriers and impacts of digitalisation in rural areas from

the viewpoint of experts. *Information and Software Technology, 145*, 106816. https://doi.org/10.1016/j.infsof.2021.106816

Food and Agriculture Organization (2020). Agricultural Extension and Advisory Services: Guidance. Food and Agriculture Organization of the United Nations.

Gani, A., Mamat, R., Nizar, M., Yana, S., Rosdi, S. M., Zaki, M., & Eko Sardjono, R. (2023). The Business Model for Access to Affordable RE on Economic, Social, and Environmental Value: A Review. *Geomatics and Environmental Engineering*, *17*(5).

Gyong, Y. E., & Ahmed, A. T. (2024). Analysis of Commercial Agriculture Credit Scheme on Profitability of Rice Farming in Kano State, Nigeria: Strategy for Industrial Growth. NIU Journal of Social Sciences, 10(1), 19-26.

Hoang, V., & Nguyen, V. (2023). Determinants of small farmers' participation in contract farming in developing countries: A study in Vietnam. *Agribusiness*, *39*(3), 836-853.

Ivanov, D., Dütting, P., Talgam-Cohen, I., Wang, T., & Parkes, D. C. (2024). Principal-Agent Reinforcement Learning: Orchestrating AI Agents with Contracts.

Karakara, A., Nunoo, J., & Coffie, M. (2024). Gender, Forms of Land Ownership and Agriculture Value Chain Participation: Empirical Insights from Smallholder Farmers in Cote d'Ivoire and Nigeria. *African Journal on Land Policy and Geospatial Sciences*, *7*(3), 775-793.

Kassie, M., Teklewold, H., Jaleta, M., Marenya, P., & Erenstein, O. (2020). Understanding the adoption of a portfolio of sustainable intensification practices in eastern and southern Africa. *Land Use Policy, 99, 104896*.

Khan, I. A., & Idrees, M. (2024). Factors Affecting the Wheat Yield Variation Among Small Holder Farmers: An Social Assessment of their Knowledge, Attitude and Practices towards Adoption of Modern Agriculture Technologies and Hybrid Seed. *Pakistan Journal of Agricultural Sciences*, *61*(3).

Khan, R. N. (2024). ANOVA. *Statistics: Meaning from data*.

Lam, D., & Leibbrandt, M. (2023). Demographic Challenges for Global Labor Markets in the 21st Century, Africa in a Changing World.

Lindsjö, K., Mulwafu, W., Andersson Djurfeldt, A., & Joshua, M. K. (2021). Generational dynamics of agricultural intensification in Malawi: Challenges for the youth and elderly smallholder farmers. *International Journal of Agricultural Sustainability*, *19*(5-6), 423-436.

Liu, J., & Xu, Y. (2022). T-Friedman test: a new statistical test for multiple comparisons with an adjustable conservativeness measure. *International Journal of Computational Intelligence Systems*, *15*(1), 29.

Manda, S., & Miti, C. (2024). Does value chain inclusiveness increase smallholder resilience during pandemics? Lessons from the Zambia's sugar-belt. *Journal of International Development, 36(2), 773-794.*

Mburu, S., et al. (2022). Household size and its effect on food security in rural Kenya. *Journal of Rural Studies.*

Meemken, E.-M., & Bellemare, M. F. (2020). Smallholder farmers and contract farming in developing countries. *Proceedings of the National Academy of Sciences, 117*(1), 259–264.

National Bureau of Statistics. (2022). Demographic Statistical Bulletin.

National Bureau of Statistics. (2024). Foreign Trade in Goods Statistics Report.

Ochieng, J., et al. (2020). Adoption of agricultural technologies and climate resilience in Kenya. Climate Risk Management.

Ojo, T. O., et al. (2021). Agricultural productivity, rural poverty, and inclusive growth in sub-Saharan Africa: A cross-country analysis. *World Development*.

Olawuyi, S. O., & Mushunje, A. (2019). Climate change and variability in Nigeria: a review of impacts on agriculture and food security. *Journal of Agricultural Economics and Development.*

Oloyede, A. O., Abiola, K. A., & Adeoye, S. O. (2022). Impact of Out-Grower Schemes on Wheat Production in Northern Nigeria. *Journal of Agricultural Economics and Development*, 10(2), 134-148.

Onyango, C. M., Nyaga, J. M., Wetterlind, J., Söderström, M., & Piikki, K. (2021). Precision agriculture for resource use efficiency in smallholder farming systems in sub-saharan africa: A systematic review. *Sustainability*, *13*(3), 1158.

Poku, A. G., Birner, R., & Gupta, S. (2018). Making contract farming arrangements work in Africa's bioeconomy: Evidence from cassava out-grower schemes in Ghana. Sustainability, 10(5), 1604.

Pratomo, D. S., Ningsih, D. N., Fahadayna, A. C., Arisetyawan, K., Al Ayyubi, M. S., Natalia, C., ... & Prastiwi, L. F. (2024). Analysing the Factors Influencing Green Job Participation and Income Effects Using National Labor Force Data. Journal of Human, Earth, and Future, 5(3), 513-527.

Sennuga, S. O., Bamidele, J., Joel, O. J., Olaitan, M. A., Joel, A. F., & Raymond, T. (2024). Assessment of the Factors Affecting Smallholder Livestock Farmers' Use of Information and Communication Technologies to Access Market Information in Nasarawa State, Nigeria. *Journal of Veterinary and Biomedical Sciences*, *6*(2), 17-27.

Swinnen, J., & Kuijpers, R. (2020). *Inclusive value chains to accelerate poverty reduction in Africa*. The World Bank. https://doi.org/10.1596/33397 Sciences, 10(1), 19-26.