

IMPACT OF AGRICULTURAL MECHANIZATION POLICY ON LIVING STANDARD OF SMALLHOLDER RICE FARMERS IN NORTH EAST NIGERIA

¹Bashir Abdullahi,²Ruqayya Aminu Gar, *PhD* and ³Mohammed Nuru Umar, *PhD*

¹PhD Student, ^{2&3}Department of Political Science, Faculty of Social Sciences, Sa'adu Zungur
University, Bauchi, Bauchi State

Corresponding Author Email: bashirabdullahi395@gsu.edu.ng

Abstract

Agricultural mechanization has re-emerged as a critical development strategy for improving rural welfare in sub-Saharan Africa. In North-East Nigeria an area affected by prolonged conflict and structural underdevelopment, the North East Development Commission (NEDC) introduced a mechanization support programme aimed at enhancing rice production and improving farmers' living standards. This study assesses the impact of this mechanization policy on the welfare of smallholder rice farmers across Adamawa, Borno, and Gombe States. Using a quantitative research design, data were collected from 396 beneficiaries selected through a multistage cluster sampling technique. Descriptive statistics and simple linear regression were employed to determine the relationship between access to mechanization inputs (tractors, improved seeds, fertilizers, pesticides, and herbicides) and farmers' living standards. The findings reveal a statistically significant positive effect of mechanization support on income levels, food security, household assets, and general welfare of rice farmers. This study provides empirical evidence that region-specific mechanization interventions implemented by the NEDC contribute meaningfully to livelihood improvement in post-conflict communities. The study recommends scaling-up mechanization access, strengthening extension support, and mainstreaming mechanization into long-term agricultural recovery strategies for the North-East.

Keywords: *Agricultural mechanization; North East Development Commission; Living Standards; Rice Farmers.*

Introduction

Agricultural mechanization is widely recognised as an important pathway for improving agricultural productivity, reducing labour burdens, and enhancing rural livelihoods in many low- and middle-income countries (Daum & Birner, 2020). Mechanisation contributes to agricultural development through different channels. It improves the timeliness and efficiency of land preparation, facilitates the effective use of complementary farm inputs such as fertilizers and improved seeds, reduces labour constraints and post-harvest losses, and, when properly implemented, has the potential to increase farm output, income, and overall household welfare (Daum & Birner, 2020; Gebiso, 2024). In Africa and other developing mechanisation contributes not only to higher agricultural productivity

but also to improved farmer incomes and labour efficiency, which may ultimately strengthen household access to food, healthcare, and education services (Gebiso, 2024; Zhang et al., 2023).

In Nigeria, the development of agricultural mechanisation has followed an inconsistent path. Although government agencies such as Federal Ministry of Agriculture and Food Security have introduced several mechanisation programmes from the post independence to the present, the intensity of mechanisation remains relatively low compared to the country's agricultural potential. Significant regional disparities also exist in terms of access to tractors and mechanised agricultural services (Takeshima & Lawal, 2020). Research suggests that access to tractors and other mechanisation services can increase cultivated farmland and improve production efficiency, especially when supported by functional service markets and the timely provision of complementary agricultural inputs such as fertilizers and improved seeds (Takeshima & Lawal, 2020; FAO, 2020).

The North-East region of Nigeria presents a unique and challenging environment for evaluating the welfare implications of agricultural mechanisation. Prolonged insurgency in the region disrupted farming activities, displaced rural populations, weakened infrastructure, and limited access to essential agricultural and social services. As a result, food insecurity and poor living conditions in the region have remained more severe (World Bank, 2020). In response to these challenges, the North-East Development Commission (NEDC) introduced a regional stabilization and recovery strategy through the North-East Stabilization and Development Master Plan (NESDMP), which incorporated agricultural mechanisation interventions beginning in 2020. These interventions included the distribution of tractors and agricultural equipment, the supply of improved seeds and agro-inputs, and support for agricultural service delivery systems aimed at reviving farming activities and improving livelihoods in conflict-affected communities (NESDMP, 2020). While programme implementation records indicate substantial efforts in distributing equipment and inputs, there remains limited empirical and quantitative evidence regarding the extent to which these mechanisation interventions have translated into measurable improvements in the living standards of smallholder rice farmers in the North-East region.

Against this background, this study quantitatively examines the impact of NEDC-supported mechanisation inputs on the living standards of smallholder rice farmers in Adamawa, Borno, and Gombe States. The study utilises survey data collected from programme beneficiaries and adopts a regression-based analytical framework to examine the relationship between mechanisation inputs, including access to tractors, improved seeds, fertilizers, and pesticides, and key indicators of household welfare such as food security, household income, access to healthcare and education, and

housing conditions. By doing so, the study seeks to provide robust and policy-relevant evidence on the extent to which agricultural mechanisation interventions are contributing to improved living standards in a fragile and post-conflict environment in North-East Nigeria.

Literature Review and Theoretical Framework

Concept of Agricultural Mechanization Policy

Agricultural mechanization policy refers to deliberate government actions, institutional frameworks, and intervention programmes aimed at promoting the use of machinery and modern technology in agricultural production. These policies are designed to enhance productivity, reduce dependence on human labour, improve efficiency in farm operations, and strengthen rural livelihoods through increased access to mechanized services such as tractors, harvesters, planters, and irrigation equipment. According to the Food and Agriculture Organization (FAO, 2016), agricultural mechanization is not limited to the replacement of human labour with machines, but rather a broader process that improves the timeliness, precision, and efficiency of agricultural operations. In this sense, mechanization policy plays a critical role in ensuring that farmers, particularly smallholders, can access appropriate technologies that match their production needs and local conditions. In Nigeria, mechanization policy has evolved through several government initiatives aimed at increasing food production and reducing rural poverty, yet access to machinery remains largely limited to a small proportion of farmers, particularly in rural communities of the North-East region (Takeshima & Lawal, 2020).

Concept of Smallholder Farmers

Smallholder farmers are typically defined as rural agricultural producers who operate on small plots of land, often less than two hectares, relying primarily on family labour and simple tools for cultivation. These farmers constitute the majority of agricultural producers in Nigeria and play a vital role in national food security, especially in staple crops such as rice, maize, and millet. Smallholder farming is characterized by limited access to capital, low levels of mechanization, dependence on rainfall, and vulnerability to climate and market shocks. As a result, productivity levels tend to be low compared to commercial farming systems. Daum & Birner (2020) argued that improving access to mechanization services can significantly enhance the productivity and income levels of smallholder farmers by expanding cultivated land area, reducing labour constraints, and improving the efficiency of farm operations.

In the North-East region of Nigeria, smallholder farmers face additional challenges such as insecurity, displacement, and limited access to agricultural inputs and extension services. These constraints make mechanization policy particularly relevant, as it has the potential to support recovery and improve agricultural livelihoods.

Concept of Living Standard

Living standard refers to the level of material well-being enjoyed by individuals or households, often measured through indicators such as income, food security, housing conditions, education, health access, and ownership of assets. It reflects the overall quality of life and economic comfort of individuals within a society. For smallholder farmers, living standards are closely tied to agricultural productivity and income generation. When farm output increases due to improved technologies such as mechanization, households are more likely to experience better food availability, higher income, and improved access to social services. Empirical evidence suggests that agricultural mechanization contributes to improved living standards by reducing production costs, increasing farm income, and freeing up labour for other income-generating activities (FAO, 2017; World Bank, 2019). However, the impact of mechanization on living standards is not automatic. It depends on several mediating factors such as access to markets, availability of complementary inputs, infrastructure, and the inclusiveness of mechanization policies. In contexts like North-East Nigeria, where insecurity and weak infrastructure persist, these factors significantly shape how mechanization translates into household welfare outcomes.

Empirical Review

Several studies have been conducted to ascertain the impact of mechanisation in raising agricultural productivity. Daum and Birner (2020) synthesis highlights that mechanization is not a single technological leap but a set of context-dependent interventions whose effectiveness depends on service markets, input access, operator availability, and institutional design. Their review stresses the need for regionally specific empirical work to move policy beyond assumptions and to design inclusive mechanization strategies.

Nigeria's mechanization landscape has been well documented as characterised by very low tractor-to-land ratios and weak machinery service markets (Takeshima & Lawal, 2020). National policy documents and surveys indicate that Nigeria's tractorization index remains far below FAO recommendations, a factor often invoked to explain persistently low cereal yields despite high potential. This structural under-mechanization is compounded by fragmented machinery hire

services, limited after-sales support, and weak local manufacturing capacity for spare parts, all of which constrain the scalability and sustainability of mechanization programmes (Takeshima & Lawal, 2020; NATIP, 2022). Recent Nigerian studies focused on rice and other staples provide empirical support that mechanization improves technical efficiency and profitability when combined with proper agronomy and input packages. Several recent analyses of rice systems in Nigeria show that mechanized operations (land preparation, planting, and harvesting) are associated with positive yield differentials and reduced unit labour costs compared with manual methods (Umar et al., 2021; Adeoye & Kolapo, 2023). These results underscore that mechanization's potential for welfare improvement is mediated by the simultaneous availability of complementary inputs and functioning value-chain linkages.

The policy interest in mechanization in Nigeria's North-East has grown due to the region's unique post-conflict recovery needs. The North East Development Commission (NEDC) rolled out mechanization support tractors, implements and input distribution as part of its stabilization and recovery agenda beginning in 2020 (NEDC NESDMP; Daily Trust, 2020). Early programme reports and media coverage indicate tangible distributions of tractors and input packages in selected states, though rigorous peer-reviewed evaluations of productivity and welfare impacts in the North-East remain limited. This gap matters because conflict and insecurity alter service delivery channels, access to land and labour supply, and therefore the mechanics by which mechanization translates into farm-level welfare (Daily Trust, 2020; NEDC NESDMP).

A growing body of cross-country and sub-national work highlights the institutional and market conditions needed for mechanization to translate to household welfare. Studies identify five recurring enablers: (i) functioning hire markets or service provision, (ii) access to complementary inputs (quality seed, fertilizer), (iii) extension and operator training, (iv) access to finance or risk-mitigation mechanisms, and (v) enabling infrastructure (roads, repair workshops) (Daum & Birner, 2020; FAO, 2021). Where these enablers are weak, mechanization risks remaining a marginal technology mainly benefiting larger or better connected farms.

Several recent empirical papers stress the welfare linkages more directly. Ma (2024) and Gebiso (2024) show that mechanization by improving timeliness and reducing post-harvest loss can raise on-farm incomes and food availability, thereby supporting consumption smoothing and investments in health and education. These studies use household survey microdata and quasi-experimental methods to trace how yield gains from mechanization feed into household budgets; they also caution

that effects are heterogenous and depend strongly on farm size, gendered access to services, and local labour market conditions.

Cost and financing remain central in the literature. The capital intensity of mechanization and the scarcity of affordable credit limit uptake by smallholders; lease-to-own, public subsidised hire centres and pay-as-you-go digital models are emerging as practical solutions (World Bank; Global Agricultural Productivity case studies). In Nigeria, pilot partnerships (public-private and NGO-led models) have attempted to scale out mechanization through service providers rather than asset distribution to individual farmers a strategy that can be more inclusive if sustainably managed. The post-conflict dimension adds further complexity: insecurity increases transaction costs, reduces the willingness of private providers to operate, and raises the risk of equipment loss or damage. Empirical work on conflict-affected agricultural systems shows that interventions that ignore security dynamics often underperform; effective mechanization in such contexts requires integrated programming combining equipment, security arrangements, local operator training, and community engagement (Omotayo et al., 2025; JICA Nigeria mechanization notes). Methodological advances in recent years strengthen the capacity to measure mechanization's welfare impacts. Researchers increasingly use matched comparisons, panel data, and regression models that control for selection into mechanization services; moreover, studies now disaggregate the effects by intensity and type of mechanization (e.g., tractor hiring vs. owner-operator, small-scale power tillers) to reveal nuanced welfare pathways (Kotu, 2023; Ma, 2024). These methodological refinements inform the present study's design, which employs a regression framework to quantify associations between access to mechanization inputs and living-standard indicators among rice-farming households in Adamawa, Borno and Gombe.

Theoretical Framework

This study adopted the theory of Induced Agricultural Innovations

The Theory of Induced Agricultural Innovations (Hayami & Ruttan, 1970) asserts that technological change in agriculture is driven by shifts in the relative scarcity and cost of production factors such as land, labor, and capital. Innovations are "induced" when farmers and agribusinesses adopt technologies that substitute scarce or less productive resources with more efficient alternatives, responding to economic pressures and environmental constraints. In labor-scarce regions, farmers tend to adopt labor-saving technologies such as tractors, threshers, and herbicides, whereas in land-constrained areas, they adopt land-saving innovations such as improved seeds, fertilizers, and irrigation systems to enhance crop output.

The theory emphasizes that the adoption of appropriate technologies leads directly to higher productivity and increased income (Hayami & Ruttan, 1984). Mechanized farming and the use of improved inputs enable farmers to cultivate larger areas efficiently, reduce post-harvest losses, and optimize resource use. For rice farmers, the introduction of tractors, improved seed varieties, fertilizers, and herbicides can significantly increase yield per hectare, translating into higher earnings. This increase in income enables farmers to meet household needs, invest in education, healthcare, and better living conditions, thereby improving their overall standard of living.

Methodology

This study adopted a quantitative research design to assess the impact of the North East Development Commission (NEDC) Agricultural Mechanization Policy on the living standards of smallholder rice farmers in North-East Nigeria. The design enabled the systematic collection and analysis of numerical data to measure farmers' experiences with mechanization inputs and their associated welfare outcomes. The study covered three states Adamawa, Borno, and Gombe which were selected purposively because they are core intervention areas of the NEDC and represent diverse yet comparable post-conflict agricultural conditions within the region. The target population comprised 4,500 smallholder rice farmers who benefited from the NEDC mechanization programme, distributed across the three states. To determine the sample size, the Taro Yamane formula was applied, yielding a sample of 400 respondents. In line with recommended practices for improving response quality and minimizing non-response bias, the sample size was increased by 10 percent to 440 respondents. A structured questionnaire was used as the primary instrument for data collection, capturing information on farmers' access to mechanization inputs such as tractors, improved seeds, fertilizers, herbicides, and pesticides, as well as welfare indicators including income, food security, and household wellbeing.

A multi-stage sampling procedure was employed. First, the three states were treated as natural clusters representing the geographical implementation zones of the NEDC mechanization programme. From these clusters, simple random sampling was applied to select beneficiaries from the NEDC database, ensuring that every registered rice farmer had an equal chance of inclusion. The questionnaires were administered physically with the support of trained research assistants to enhance coverage and accuracy. Completed questionnaires were screened, coded, and entered into the Statistical Package for the Social Sciences (SPSS) version 26 for analysis. Both descriptive and inferential statistics were employed. Descriptive statistics, including means and standard deviations, were used to summarize farmers' responses on mechanization access and living standard indicators.

A simple linear regression model was used to examine the effect of agricultural mechanization on living standards, with mechanization inputs as the independent variable and farmers' welfare as the dependent variable.

Results and Discussion

Table 1: Questionnaire Distribution and Response Rate

S/N	Details	Frequency	Percentage (%)
1	Distributed copies of questionnaires	440	100%
2.	Returned Copies of questionnaires	414	94%
3.	Unreturned copies of questionnaires	26	6%
4.	Invalid questionnaires	18	4%
5.	Usable questionnaires	396	90%

Source: Field Survey 2025

Table 1 above shows that, 440 questionnaires were distributed representing 100% as the percentage of total sample size for the study. The researcher was able to retrieved 414 questionnaires out of the 440 distributed. Among the 414 returned questionnaires, 396 were found to be usable while 18 questionnaires were invalid. Therefore, the analysis was carried out using 396 valid questionnaires.

Table 2: Gender Distribution

Variables	Frequencies	Percentages
Male	307	78%
Female	89	22%
Total	396	100%

Source: Field Survey 2025

As revealed by the data in table 2, Out of a total of 396 respondents, 307 (78%) were male and 89 (22%) were female. This indicates a significant gender imbalance, with males comprising the majority of the sample.

Table 3: Age Distribution

Variables	Frequencies	Percentages
18-25	55	14%
26-35	74	19%
36-45	209	53%
46 and above	58	14%
Total	396	100%

Source: Field Survey 2025

Table 3 presents the age distribution of respondents. The majority, 53%, fall within the 36–45 age group, indicating this is the most represented demographic. The 26–35 and 46 and above categories each account for 19% and 14%, respectively. Similarly, those aged 18–25 also make up 14% of the sample. This suggests that while there is some representation across all age groups, respondents are predominantly middle-aged. The total number of participants surveyed is 396, reflecting a fairly broad age range overall

Table 4: Marital Status

Variables	Frequencies	Percentages
Single	69	17%
Married	211	53%
Divorced	57	15%
Widow	59	15%
Total	396	100%

Source: Field Survey 2025

In table 4 the marital status of respondent is shown. As revealed by the data, majority, 53%, are married, making them the most represented group. Singles account for 17% of the total, while both divorced and widowed individuals each represent 15%. This indicates that over half of the participants are in a marital union, with the remaining portion fairly evenly split among the other categories.

Table 5: Educational Qualification

Variables	Frequencies	Percentages
No Formal Education	162	41%
Primary Education	135	34%
Secondary	50	13%
Tertiary Education	49	12%
Total	396	100%

Source: Field Survey 2025

Table 4.5 highlights the educational qualifications of the respondents. A significant portion, 41%, have no formal education, making this the largest group. Those with primary education follow closely at 34%, while only 13% have completed secondary education. The smallest group, 12%, holds tertiary qualifications. This suggests that the majority of respondents have low levels of formal education, with less than a quarter attaining secondary or higher education.

Table 6 State of Residence

Variables	Frequencies	Percentages
Adamawa	128	32%
Borno	127	32%
Gombe	141	36%
Total	396	100%

Source: Field Survey 2025

Table 6 above presents the distribution of respondents by state of residence. Out of a total of 396 participants, the highest proportion, 36% (141 respondents), reside in Gombe State. Adamawa and Borno States have nearly equal representations, with 32% (128 respondents) and 32% (127 respondents) respectively. This indicates a fairly balanced sampling across the three states, with a slight predominance from Gombe.

Table 7: Impact of Agricultural Mechanization Policy on Living Standard of Rice Farmers

Statement	Mean	SD	Decision
Mechanization Policy led to Food affordability	3.56	0.919	Accepted
Mechanization Policy led to affordability of Good health care service	3.75	0.786	Accepted
Mechanization Policy led to affordability of Quality Education	3.72	0.924	Accepted
Mechanization Policy led to affordability of Safe and housing	3.74	0.875	Accepted
Mechanization Policy led to affordability Clean and portable water	3.96	0.872	Accepted
Decision Mean: 3.0	Average Mean: 3.7		

In table 7, the perceived impact of mechanization policy on the living standards of rice farmers, based on five key indicators is presented. All statements received mean scores above the decision threshold of 3.0, indicating general agreement among respondents. The highest-rated impact was on the affordability of clean and portable water (Mean = 3.96, SD = 0.872), suggesting that mechanization significantly enhanced access to basic utilities. This was closely followed by improved access to good healthcare services (Mean = 3.75, SD = 0.786), safe and well-maintained housing (Mean = 3.74, SD = 0.875), and quality education (Mean = 3.72, SD = 0.924). The lowest, yet still accepted, was food affordability (Mean = 3.56, SD = 0.919). The overall average mean of 3.7 implies that the mechanization policy has positively influenced various dimensions of farmers' living standards, particularly in areas essential for well-being and human development. This indicates a strong perception among rice farmers that mechanization contributes not only to productivity but also to improved quality of life.

Table 8: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.518a	0.268	0.260	0.40016

Source: SPSS version 26

The model summary in table 8 shows that there is a moderate positive relationship ($R = 0.518$) between agricultural mechanization policy and the living standard of rice farmers. The R Square value of 0.268 indicates that 26.8% of the variation in the living standard of rice farmers can be explained by the mechanization policy, suggesting that the policy has a noticeable impact. The Adjusted R Square of 0.260, slightly lower than the R Square, adjusts for the number of predictors and confirms that the model's explanatory power remains relatively stable when generalized to the population. This suggests that mechanization policy plays an important role in improving living standard of rice farmers.

Table 9: ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	22.914	4	5.728	35.773	0.000b
Residual	62.611	391	0.160		
Total	85.524	395			

Source: SPSS version 26

The data in table 9 assesses the overall significance of the regression model examining the impact of agricultural mechanization policy on the living standard of rice farmers. The regression sum of squares is 22.914 with 4 degrees of freedom, indicating the portion of total variability in living standards explained by the model. The mean square for regression is 5.728, and the F-statistic is 35.773, which is quite high. The significance value (Sig.) is 0.000, which is less than 0.05, confirming that the model is statistically significant. This means that the agricultural mechanization policy, as a group of predictors, has a meaningful effect on the living standard of rice farmers. Overall, the analysis confirms that the independent variables in the model significantly predict changes in the dependent variable.

Table 10: Regression Coefficients Matrix

Predictors	Unstandardized B	Coefficient Error	Standardized Coefficients Beta	t	Sig.
Technology (Tractor)	0.243	0.044	0.264	5.489	0.000
Improved seeds	0.085	0.031	0.124	2.724	0.007
Fertilizer	0.024	0.038	0.031	0.638	0.524
Pesticides/Herbicides	0.261	0.047	0.280	5.593	0.000

Source: SPSS version 26

The data in table 10 reveals the individual impact of various components of agricultural mechanization on the living standard of rice farmers. The use of tractors ($B = 0.243$, $p = 0.000$) and pesticides/herbicides ($B = 0.261$, $p = 0.000$) have strong, statistically significant positive effects, with standardized beta values of 0.264 and 0.280 respectively, indicating they are the most influential predictors in the model. Improved seeds also have a significant positive effect ($B = 0.085$, $p = 0.007$), though to a lesser extent ($Beta = 0.124$). Fertilizer use, however, shows a weak and statistically insignificant effect ($B = 0.024$, $p = 0.524$), suggesting it does not significantly influence farmers' living standards in this model. The t-values support these findings, with high t-scores for tractors and pesticides/herbicides, moderate for improved seeds, and very low for fertilizer. Overall, mechanization inputs like tractors and chemical applications are key contributors to improved living standards, while fertilizer use appears less impactful in this context.

Discussion of Findings

The findings of this study demonstrate that the Agricultural Mechanization Policy implemented by the North East Development Commission (NEDC) has had a notable positive effect on the living standards of smallholder rice farmers in North-East Nigeria. The descriptive results (Table 1) show that all five welfare indicators exceeded the decision mean benchmark of 3.0, indicating broad agreement that mechanization improved various aspects of farmers' livelihoods. The highest-rated outcome was improved access to clean and portable water (Mean = 3.96), suggesting that mechanization enhanced income stability and enabled households to afford essential utilities. Similarly, access to good healthcare services (Mean = 3.75), safe housing (Mean = 3.74), and quality education (Mean = 3.72) all scored highly. Although food affordability had the lowest mean (3.56), it was still accepted, reflecting the role of mechanization in improving food security and reducing household vulnerability. These findings align with contemporary literature that emphasizes the indirect welfare benefits of mechanization, particularly through increased income and reduced labour burden.

The regression results further reinforce these descriptive patterns. The model summary shows a moderate positive relationship between mechanization policy and living standards ($R = 0.518$), with an R Square of 0.268 indicating that 26.8% of the variation in farmers' living standards is explained by the mechanization policy. This suggests that mechanization plays an important, though not exclusive, role in shaping welfare outcomes among farmers. The ANOVA results ($F = 35.773$, $p < 0.001$) confirm that the model is statistically significant, demonstrating that the policy intervention has a meaningful predictive effect on living standards. This aligns with the view that access to tractors, inputs, and other mechanization support reduces production constraints, strengthens productivity, and ultimately enhances household welfare. Overall, the quantitative evidence shows that the NEDC mechanization policy has contributed positively to improving welfare indicators among rice farmers in the region.

Conclusion

This study concludes that the Agricultural Mechanization Policy of the NEDC has made a measurable and meaningful contribution to improving the living standards of smallholder rice farmers in North-East Nigeria. The descriptive findings reveal that farmers perceive notable improvements in essential welfare indicators, including access to clean water, healthcare, housing, food, and education. The significant regression results confirm that mechanization policy positively predicts living standard outcomes, accounting for over one-quarter of the variance in welfare levels among farmers. These findings underscore the importance of mechanization not only as a driver of productivity but also as a strategic tool for enhancing human development in a post-conflict region. Overall, the study provides strong empirical evidence that mechanization policies can improve the socioeconomic wellbeing of farmers when appropriately implemented.

Recommendations

Based on the findings, the following recommendations are proposed:

- i. NEDC should expand the programme to reach more smallholder farmers and ensure wider accessibility of tractors and farm inputs.
- ii. Subsidies on tractors, improved seeds, and inputs should be made more consistent and targeted to smallholder farmers who are most constrained.
- iii. There should be technical support on operating machinery, maintaining equipment, and using improved inputs effectively.
- iv. Regular monitoring and evaluation should be prioritized by Government to track welfare improvements and ensure that mechanization interventions remain responsive to farmers' needs.
- v. Mechanization should be complemented with rural water supply projects, primary healthcare programs, and educational support to sustain the broader welfare benefits identified.

References

- Adeoye, A. S., & Kolapo, A. F. (2023). Effects of mechanized rice farming on productivity and profitability among Nigerian smallholders. *Journal of Agricultural Economics and Rural Development*, 15(2), 45-59.
- Daum, T., & Birner, R. (2020). Agricultural mechanization in Africa: Insights from Ghana and Kenya. *International Journal of Agricultural Sustainability*, 18(5), 490-507. <https://doi.org/10.1080/14735903.2020.1749489>
- Daily Trust. (2020). NEDC distributes tractors and inputs to support farmers in North-East Nigeria. Daily Trust Newspaper.
- FAO. (2020). Sustainable mechanization in Africa: Guidelines for implementation. *Food and Agriculture Organization of the United Nations*.
- FAO. (2021). Agricultural mechanization: A key input for sustainable crop production intensification. Food and Agriculture Organization.
- Gebiso, T. (2024). Mechanization, productivity, and household welfare in smallholder farming systems. *Journal of Development and Agricultural Economics*, 16(1), 12-25.

- Hayami Y., & Ruttan VW (1970) Factor prices and technical change in agricultural development: The United States and Japan, 1880-1960. *J Political Econ* 78(5):1115.
<https://doi.org/10.1086/259694>.
- Hayami Y., & Ruttan, V.W (1984). *Agricultural Development: An International Perspective*. John Hopkins University Press.
- JICA Nigeria. (2025). Mechanization and agricultural recovery in conflict-affected regions: Field technical report. *Japan International Cooperation Agency*.
- Kotu, B. (2023). Intensity of mechanization and welfare outcomes among smallholder farmers. *African Journal of Agricultural Research*, 19(4), 233-245.
- Ma, W. (2024). Adoption and intensity of agricultural mechanization and smallholder welfare outcomes. *World Development*, 167, 106186.
<https://doi.org/10.1016/j.worlddev.2023.106186>
- Mrema, G. C., Baker, D., & Kahan, D. (2020). Agricultural mechanization in sub-Saharan Africa: Time for a new look. FAO Rural Infrastructure and Agro-Industries Division Working Paper.
- NATIP. (2022). National Agricultural Technology and Innovation Policy (2022-2027). Federal Ministry of Agriculture and Rural Development, Nigeria.
- NEDC. (2020). North-East Stabilization and Development Master Plan (NESDMP). North East Development Commission.
- Omotayo, A. O., Yusuf, S. A., & Alawode, O. O. (2025). Agricultural service delivery and mechanization interventions in insecurity-affected regions of Nigeria. *Journal of Rural Development Studies*, 41(1), 77-94.
- Takeshima, H., & Lawal, A. (2020). Overview of the Nigerian agricultural mechanization subsector. IFPRI Discussion Paper 01954. *International Food Policy Research Institute*.
- Umar, S., Ibrahim, M. Y., & Mohammed, A. (2021). Mechanized operations and technical efficiency of rice farmers in Nigeria. *Nigerian Journal of Agricultural Economics*, 11(1), 95-108.
- World Bank. (2020). Nigeria: North-East recovery and peacebuilding assessment. World Bank Group.

Zhang, X., Li, Z., & Jin, S. (2023). Mechanization and rural welfare: Evidence from smallholder-dominated systems. *Food Policy*, 118, 102425.
<https://doi.org/10.1016/j.foodpol.2023.102425>.