

Gendered Control of Post-Harvest Decisions and Its Impact on Rice Losses in Southwest Nigeria

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Abstract: Rice is a major staple crop in Nigeria, but post-harvest losses (PHL) remain high at 15–30%. Women dominate the most labour-intensive post-harvest operations such as parboiling and drying but are often excluded from decision-making and technology access. This gender asymmetry may be responsible for continued PHL despite technology availability. The research investigates the influence of gendered control over post-harvest choices on technology adoption and measurable rice losses in Southwest Nigeria. Cross-sectional mixed-methods design was employed in Osun and Ekiti States rice clusters. Survey, participatory decision-making matrix, and standardised field loss assessment were employed in collecting data from 300 households. Descriptive statistics, binary logistic regression, and structural equation modelling (SEM) were employed in analysing the data, augmented by thematic analysis of qualitative data. Women did most of the parboiling (95%) and drying (88%) work, but men still had overall control of major money and technology decisions, i.e., storage (75%) and marketing (70%). Female decision-making households were 3.37 times more likely to store hermetically ($p < 0.01$). Field results indicated significantly lower mean loss in female-managed households (10.2%) compared to male-managed households (16.8%, $p < 0.001$). SEM confirmed that women's decision-making authority tamed losses indirectly by higher adoption of improved technologies. Empowerment of women to engage in post-harvest decision-making has a profound influence on loss-reduction technology adoption and PHL reduction. Interventions that make technologies available without transforming intra-household power relations can realise partial success.

Keywords: Post-harvest losses, gender, decision-making, rice, food security, value chain

INTRODUCTION

Rice is arguably the most important staple food in Nigeria, both from domestic food security and Nigeria's economy. Nigeria is the largest producer of rice in West Africa, with production in recent years averaging between 8.0 and 9.1 million tonnes per year, but demand has always been more than the supply (Adewumi et al., 2022; Gao et al., 2023). Current consumption is 7.7 million tonnes of milled rice per annum, driven by increased urbanisation and dietary change, making the country dependent on imports to meet the gap (Ragasa et al., 2019). Rice has become part of diets for both rural and urban parts of Southwest Nigeria, namely Ekiti and Osun States, recording its crucial place in local household economies and national food security (Nwankwo & Iheanyi 2025; Afolayan et al., 2024; Ojo et al., 2025).

Despite production increases, post-harvest losses (PHL) remain a major problem. Studies estimate that 15% to 30% of Nigerian rice production is lost after harvesting, mainly at the drying, storage, and milling phases (Affognon et al., 2015; Ogundele, 2022). Such inefficiencies equate to wastage of labour, land, and capital, as well as reduced incomes for households and national food self-sufficiency (Adewumi et al., 2022). Having PHL resolved is thus as vital as increasing output if

Nigeria is to achieve its food security target (Ojo et al., 2025; Adeagbo et al., 2026).

The rice value chain is also extremely gendered. Gender participation refers to the physical involvement of men and women in post-harvest tasks such as parboiling, drying, and milling, while decision-making power reflects control over strategic choices, including technology adoption, storage methods, and marketing decisions. Although women participate extensively in post-harvest rice operations in Nigeria, their involvement rarely translates into authority over key decisions that determine efficiency and loss outcomes. Land preparation, irrigation, and ploughing are the exclusive domains of men, while sowing, transplanting, parboiling, drying, milling, and retailing are major areas where women are involved (Nwankwo & Iheanyi 2025; Ragasa et al., 2019). However, women's heavy labour input is not matched with decision-making authority or productive resource access, primarily due to socio-cultural customs (Doss & Quisumbing, 2020). The disparity constrains their ability to implement technologies such as hermetic storage and improved parboiling technologies that have been established to reduce post-harvest losses (Gaya et al., 2017).

Gender relations have been shown to impact agriculture productivity, innovation

adoption, and household welfare (Farnworth et al., 2020). In Nigeria, though, little evidence is available to link intra-household decision-making power directly with measurable PHL effects. This is a significant gap, particularly in Southwest Nigeria, where rice is a staple and source of livelihood, and where women are over-represented in post-harvest activities. While women dominate post-harvest labour, participation does not necessarily translate into control over strategic decisions such as storage, marketing, and technology use (Awosanmi et al., 2024). Unlike most prior studies that rely on self-reported losses, this study uses gravimetric field measurement and applies structural equation modelling to trace the causal pathway from gendered decision power to technology adoption and loss reduction.

This study focuses on decision-making power rather than mere labour contribution. This study addresses this gap by investigating the relationship between gendered control of post-harvest decisions and rice losses in Southwest Nigeria. The specific objectives of the study are to assess and map gender roles in post-harvest rice

handling across Ekiti and Osun States; to examine the relationship between women's decision-making power and adoption of improved, waste-reducing practices; to quantify and compare rice losses between male- and female-managed post-harvest operations and to recommend gender-sensitive strategies to reduce waste and enhance equity in the rice value chain. Unlike most previous studies that rely on self-reported post-harvest losses, this study employs gravimetric field measurement to objectively quantify losses and applies structural equation modelling (SEM) to empirically trace the pathway linking gendered decision-making power, technology adoption, and post-harvest loss reduction in Nigerian rice systems.

METHODOLOGY

Study area

The research was conducted in Ekiti and Osun States, which are prominent rice-producing clusters in Southwest Nigeria. The states were purposively selected due to their prevalence of smallholder rice cultivation, parboiling, and high engagement of women in post-harvest activities.

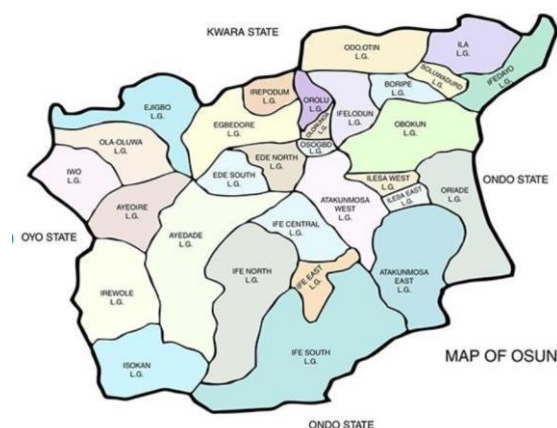


Fig 1: Map of Osun state

Research Design - Cross-sectional mixed-methods design was employed, combining quantitative and qualitative data. Statistical measurement of post-harvest losses and richer insights into intra-household decision-making dynamics were enabled by this design.

Sampling Procedure and Sample Size - A multistage stratified sampling technique was employed to ensure representativeness across the two selected states, Osun and Ekiti. In the first stage, rice-producing local government areas (LGAs) were identified in each state with the assistance of the Agricultural Development Programmes (ADPs). Three LGAs were purposively selected from each state based on their high concentration of rice farmers. These were Egbedore, Oriade and Obokun LGAs in Osun State, and Irepodun/Ifelodun, Ikole, and Ido/Osi LGAs in Ekiti State.



Fig 2: Map of Ekiti state

In the second stage, two communities were randomly selected from each of the chosen LGAs, resulting in a total of twelve communities, six in Osun and six in Ekiti. The selected communities included Iwaraja and Iloko in Oriade, Erinmo-Ijesa and Ibokun in Obokun LGAs; Osuntedo and Iragberi in Egbedore; Iyin-Ekiti and Awo-Ekiti in Irepodun/Ifelodun; Ikole-Ekiti and Oke-Ako in Ikole; as well as Ido-Ekiti and Usi-Ekiti in Ido/Osi.

At the third stage, rice-farming households in each community were stratified according to the gender of the primary post-harvest manager. The strata comprised male-managed, female-managed, and jointly managed households. In the final stage, households were randomly selected within each stratum. A total of fifty households were selected from each LGA, giving 150 households per state and a combined sample of 300 rice-farming households across both states. The sample size was determined

using Cochran's (1977) formula for finite populations.

It is important to note that households were classified based on the primary post-harvest decision-maker, not on household headship. Female-managed households refer to households in which a woman had primary authority over post-harvest handling, storage, and technology decisions, irrespective of whether the household head was male or female. Male-managed households are those where men exercised this authority, while jointly managed households are those where decisions were shared (Aduwo *et al.*, 2017).

Data Collection - Four complementary instruments were employed to obtain comprehensive and reliable data for this study. The structured household survey served as the primary quantitative instrument. It gathered detailed information on the socioeconomic characteristics of respondents, household decision-making dynamics, and the extent of technology adoption among rice farmers.

In addition to the survey, focus group discussions (FGDs) were organised to gain deeper insights into community attitudes, gender norms, and the factors influencing women's involvement in post-harvest decision-making. The discussions were conducted separately for male and female groups to encourage open and uninhibited participation.

A decision-making matrix was also utilised as a participatory tool to identify the specific roles of household members in post-harvest and income-related decisions. Through this matrix, it was possible to determine whether the husband, wife, both jointly, or other household members were primarily responsible for various post-harvest activities and financial decisions.

A loss-on-field assessment was carried out to objectively measure physical post-harvest losses. Gravimetric methods were used in line with standard procedures to estimate percentage weight losses during drying, storage, and milling stages. Rice sub-samples were collected from participating households to ensure accuracy and comparability across different processing stages.

Ethical approval for the study was obtained from the Research Ethics Committee of First Technical University, Ibadan, Nigeria, and informed consent was obtained from all participants prior to data collection. This ensured that the study adhered to the ethical standards governing research involving human participants.

Data Analysis - Quantitative data were analysed with the help of Stata 17 and R software. Descriptive statistics (means, percentages, cross-tabulations) characterised households and integrated gender roles. Binary Logistic Regression was used to identify determinants of technology adoption with explanatory variables as decision-maker gender, education, income, landholding size, and access to extension. Structural Equation Modelling (SEM) examined hypothesised relations between decision-making power, resource access, application of improved practices, and post-harvest losses. χ^2/df , CFI, TLI, RMSEA, and SRMR were used to measure model fit. Normality of loss distributions was assessed using Shapiro-Wilk tests, and homogeneity of variance using Levene's test; where mild deviations occurred, the large sample size justified the use of parametric tests. Quantitative results were triangulated with the findings to provide validity and reliability.

RESULTS AND DISCUSSION

Socioeconomic Characteristics

The socioeconomic characteristics of the 300 households surveyed are as presented in Table 1. The respondents' age was a mean of 42.5 years (± 11.4), which is indicative of a population well within the working age cohort. The household size was a mean of 6.2 members (± 2.1). The respondents had gone to school for a mean of 8.1 years (± 3.9).

Female-headed household accounted for 23.7% of the sample. The landholding size averaged 2.4 hectares (± 1.6), supporting the dominance of smallholder farming systems. Farming as a principal occupation was claimed by 81.5% of the households. Extension and credit were claimed by 41.2% and 34.6% of the interviewees, respectively. Average annual household income was ₦185,400 ($\pm 96,700$).

Table 1: Socioeconomic Characteristics of Respondents (n = 300)

Variable	Mean / % (SD)
Mean Age (years)	42.5 (± 11.4)
Household Size (average)	6.2 (± 2.1)
Education (mean years)	8.1 (± 3.9)
Female-headed household (%)	23.7 %
Average Landholding (ha)	2.4 (± 1.6)
Primary Occupation: Farming (%)	81.5 %
Access to Extension Services (%)	41.2 %
Access to Credit (%)	34.6 %
Average Household Income (₦'000)	185.4 (± 96.7)
Use of Storage method inc. Hermetic	75.3%

Source: Field Survey 2025

Post-Harvest Gender Roles

Post-harvest gender roles are shown in Table 2. Women handled most of the parboiling (95%), drying (88%), and winnowing (82%). Men dominated transport (75%) and purchasing storage

technology (75%). Decision-making in the issue of marketing was largely in the hands of men (70%), while decision-making in handling for storage was largely joint (50%).

Table 2: Division of Labour and Decision-Making in Post-Harvest Activities

Activity	Female (%)	Male (%)	Joint (%)	Primary Decision-Maker
Parboiling	95	2	3	Female (92%)
Drying	88	5	7	Joint (65%)
Winnowing	82	8	10	Female (85%)
Storage (Handling)	45	30	25	Joint (50%)
Storage (Tech Purchase)	15	75	10	Male (75%)
Transportation	10	75	15	Male (80%)
Marketing (Pricing/Sales)	35	70	15	Male (70%)

Source: Field Survey 2025

Determinants of Adopting Waste-Reducing Practices

Table 3 shows the binary logistic regression findings for adopting hermetic storage technology. The model was significant, $\chi^2(5) = 63.82$, $p < 0.001$, and the Nagelkerke R^2 was 0.324, correctly classifying 78% of cases.

Female decision-making significantly improved the chances of adoption (OR = 3.37, $p = 0.002$). Access to extension services (OR = 2.63, $p =$

0.011), education (OR = 1.13, $p = 0.031$), and income (OR = 1.002, $p = 0.042$) were also important determinants. Size of landholding was not significant. Although household income was statistically significant, the odds ratio (1.002) indicates that its substantive effect on adoption is very small, suggesting that decision-making authority and extension access matter more than income in driving technology adoption.

Table 3: Logistic Regression of Factors Influencing Adoption of Hermetic Storage

Variable	β	S.E.	Odds Ratio [Exp(β)]	p-value
Female Decision-Maker (1=Yes)	1.215	0.401	3.371	0.002
Access to Extension (1=Yes)	0.967	0.382	2.630	0.011
Education Level (Years)	0.121	0.056	1.129	0.031
Household Income (₦000)	0.002	0.001	1.002	0.042
Landholding Size (Hectares)	0.105	0.183	1.111	0.565
Constant	-3.901	0.842	0.020	<0.001

Source: Field Survey 2025

Quantitative Loss Differences by Management Type

Table 4 displays measured post-harvest loss. Female-managed households reported a mean total loss of 10.2%, while male-managed and jointly

managed households reported losses of 16.8% and 11.6%, respectively. Independent samples t-tests confirmed that losses were also significantly lower in female-managed households ($t(298) = 5.83$, $p < 0.001$).

Table 4: Mean Percentage Weight Loss by Management Type and Activity

Post-Harvest Activity	Female-Managed (%)	Male-Managed (%)	Jointly Managed (%)
Parboiling	3.1 (± 1.2)	4.8 (± 2.1)	3.5 (± 1.4)
Drying	4.5 (± 1.8)	7.2 (± 2.5)	5.1 (± 2.0)
Storage (3 months)	2.6 (± 1.1)	4.8 (± 1.9)	3.0 (± 1.3)
Total Average Loss	10.2	16.8	11.6

Source: Field Survey 2025

Structural Equation Modelling of the Decision-Power-Loss Pathway

SEM was employed to investigate the following hypothesised pathways: female decision-making influence, resource access, adoption of improved practices, and post-harvest losses. Model

fit was acceptable: $\chi^2/df = 1.89$, CFI = 0.96, TLI = 0.95, RMSEA = 0.055, and SRMR = 0.048.

Key outcomes are presented in Table 5. The level of decision-making power among women positively influenced the adoption index ($\beta = 0.61$, $p < 0.001$). Having access to resources positively influenced adoption ($\beta = 0.27$, $p = 0.004$). Enhanced

practice adoption was associated with a strong linkage with reduced losses ($\beta = -0.52$, $p < 0.001$). The overall effect of female decision-making power

on reducing losses through adoption was sizeable (-0.31), while the direct effect was negligible (-0.14 , $p = 0.081$).

Table 5: SEM Standardised Direct, Indirect, and Total Effects

Relationship	Direct Effect	Indirect Effect	Total Effect	p-value
Decision Power → Adoption Index	0.61	–	0.61	<0.001
Resource Access → Adoption Index	0.27	–	0.27	0.004
Adoption Index → Total PHL	-0.52	–	-0.52	<0.001
Decision Power → Total PHL	-0.14	-0.31	-0.45	0.081 / <0.001*
Resource Access → Total PHL	-0.08	-0.13	-0.21	0.218 / 0.007*

Source: Field Survey 2025

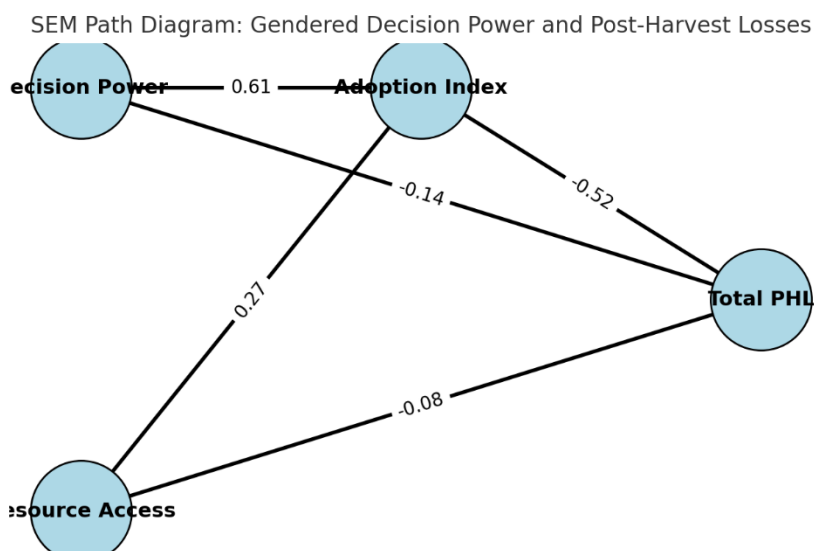


Fig 3: SEM Path Diagram

The study analysed the effect of gendered post-harvest management on technology use and rice loss in Southwest Nigeria. New evidence from the findings indicates that although women contribute most of the labour in technically challenging post-harvest activities, they remain left out of significant decision-making roles, particularly technology purchasing and marketing. This disconnection has implications for post-harvest efficiency and loss reduction.

The focus group discussion findings further reinforced the quantitative findings. For instance, a female participant from Ekiti State observed that, "We are the ones that parboil and dry the rice every day, but when it comes to buying storage bags or deciding when to sell, it is usually the men that decide." Furthermore, a male participant from Osun observed that:

"Women do most of the work after the harvest, but men will be the ones to decide because they own the land."

Another female participant stressed the significance of decision-making:

"If women can be allowed to decide on storage, we will be able to decide on storage options that will avoid spoilage."

The descriptive analysis confirmed that women dominated parboiling, drying, and winnowing but not technology purchasing and marketing decisions, which were controlled by men. This aligns with earlier studies in Ghana and Ethiopia, where women's processing dominance did not directly translate into decision-making authority (Ragasa *et al.*, 2019). The Nigerian context deepens this by showing that denial of decision-making does not merely perpetuate inequality but has measurable effects on efficiency and quantifiable post-harvest loss.

The regression result confirmed that households where women had post-harvest decision-making authority were 3.37 times more likely to adopt hermetic storage technologies. This result confirms the use of intra-household power dynamics in driving innovation adoption, as put forward by Doss & Quisumbing (2020). Theoretically, this suggests that bargaining and agency among households, rather than resource endowments, are better predictors of adoption in smallholder rice systems. Access and extension education also raised adoption, highlighting institutional assistance and human capital (Farnworth *et al.*, 2020; Asfaw *et al.*, 2019).

Quantitative farm data corroborated the efficiency returns of women's leadership. Female-headed household had significantly lower mean losses (10.2%) compared to male-headed households (16.8%). This is consistent with evidence presented by Peterman *et al.* (2014), testifying to women's meticulous management of crops. In addition to corroborating efficiency returns, the finding implies that programmes aimed at rice loss reduction not only need to induce technologies but also specifically augment women's agency to make decisions on post-harvest options, as their leadership evidently reduces wastage.

The SEM results helped to add further insight. The results indicated that female decision-making power reduced post-harvest losses primarily by its indirect influence on technology adoption, rather than directly by exerting an effect on efficiency. This finding highlights the mechanism whereby empowerment produces quantifiable impact: by enabling women to adopt and employ improved practices. Methodologically, it is a step ahead because SEM has never been employed previously to empirically track the decision–adoption–loss sequence in Nigerian rice systems. Theoretically, it adds strength to models that define empowerment as a process and not an endpoint but as a driver to technological and productivity performance (Quisumbing *et al.*, 2015; Meinzen-Dick *et al.*, 2019).

Taken collectively, these findings indicate that interventions to address post-harvest inefficiencies must accomplish more than provide technologies. Projects that provide hermetic bags, improved parboiling kit, or drying mats without altering intra-household power dynamics can reproduce current inequalities in addition to limited gains. Interventions involving gender-responsive training, promoting women's cooperatives, and increasing women's access to extension and finance, on the other hand, have the potential to transform efficiency and equity effects.

Despite the impacts, there are several limitations of this study that should be acknowledged. First, the cross-sectional design limits the extent to which changes in intra-household decision-making power and technology adoption can be accounted for over time. Intra-household gender relations are dynamic, and the associations observed here should thus be interpreted as correlational rather than strictly causal. Second, while the post-harvest losses were objectively measured using gravimetric methods, some survey components related to decision-making roles may be subjected to recall bias or social desirability bias, especially in contexts where gender norms strongly influence how responsibilities are reported. Third, endogeneity could be a concern between decision-making power and technology adoption: households adopting improved technologies may subsequently

empower women, rather than necessarily prior empowerment. While SEM helps to model indirect pathways, this cannot be eliminated. Finally, focusing on Ekiti and Osun States may make the generalisation of results to other rice-producing regions rather different in socio-cultural dynamics questionable. Future studies to be implemented longitudinally or in panel data from multiple regions would go further in yielding stronger causal inference and broader applicability.

CONCLUSION AND RECOMMENDATIONS

This study examined how gendered control of post-harvest decisions affects technology adoption and rice losses in Southwest Nigeria. The evidence shows a clear disjuncture: women contribute the bulk of labour in critical post-harvest stages such as parboiling and drying, yet men retain control over strategic decisions, particularly regarding technology acquisition and marketing. Logistic regression and SEM analyses demonstrated that empowering women in decision-making significantly increases the likelihood of adopting improved storage and handling technologies, which in turn reduces post-harvest losses. Female-managed households recorded substantially lower rice losses than male-managed ones, highlighting the efficiency benefits of inclusive decision-making.

The study's contribution lies in empirically establishing the causal chain connecting women's decision-making authority, adoption of improved practices, and measurable reductions in losses.

Based on these findings, the study recommends that interventions should prioritise the strengthening of women's decision-making power within households so that they can participate fully in technology adoption, training, and resource allocation. The dissemination of technologies such as hermetic storage, improved parboiling equipment, and modern drying facilities should be gender-sensitive and explicitly designed to reach women. Extension and training services should integrate gender-responsive modules, ensuring that women, who are central to post-harvest handling, are recognised as primary beneficiaries. Women's cooperatives should also be promoted and strengthened as a means of improving access to finance, information, and bargaining power in marketing. Furthermore, interventions should be location-specific, considering the institutional and infrastructural realities of Ekiti, Osun, and other rice-producing regions of Nigeria.

REFERENCES

- Adeagbo, I. E., Akano, O. I., Oyegoke, O. Y., Ogunbayo, I. E., & Oyelami, B. O. (2026). Understanding the nexus of postharvest losses and food insecurity: Empirical evidence from Nigeria. *Cleaner Food*

- Systems, 3, 100028.
<https://doi.org/10.1016/j.clfs.2026.100028>
- Adewumi, M. O., Ayinde, O. E., & Oloyede, O. (2022). Post-harvest losses in the Nigerian rice value chain: Evidence and implications. *Outlook on Agriculture*, 51(1), 34–45.
<https://doi.org/10.1177/003072702111073212>
- Aduwo, O. E., Aransiola, J. O., Ikuteyijo, L. O., Alao, O. T., Deji, O. F., Ayinde, J. O., Adebooye, O. C., & Oyedele, D. J. (2017). Gender differences in agricultural technology adoption in developing countries: A systematic review. *Acta Horticulturae*, 1238, 227–238.
<https://doi.org/10.17660/ActaHortic.2019.1238.24>
- Affognon, H., Mutungi, C., Sanginga, P., & Borgemeister, C. (2015). Unpacking postharvest losses in sub-Saharan Africa. *World Development*, 66, 49–68.
<https://doi.org/10.1016/j.worlddev.2014.08.002>
- Afolayan, A. F., Oke, T. T., Raji, M. A., & Olodo, H. B. (2024). The role of AI in understanding consumer behavior in the utilisation of agrochemicals: A systemic review. *International Journal of Frontiers in Chemistry and Pharmacy Research*, 4(2), 001–006.
<https://doi.org/10.53294/ijfcpr.2024.4.2.0023>
- Akinbile, C. O., Olorunfemi, I. E., & Komolafe, T. (2019). Gender roles and participation in rice production in Nigeria. *Journal of Agricultural Extension*, 23(2), 93–103.
<https://doi.org/10.4314/jae.v23i2.9>
- Akinsanmi, F. A., Olayemi, J. K., & Adeoti, A. I. (2022). Gender, decision-making and agricultural technology adoption in Nigeria. *Journal of International Development*, 34(6), 1221–1238.
<https://doi.org/10.1002/jid.3634>
- Asfaw, S., Scognamillo, A., Di Caprera, G., Sitko, N., & Ignaciuk, A. (2019). Heterogeneous impact of livelihood diversification on household welfare: Cross-country evidence from Sub-Saharan Africa. *World Development*, 117, 278–295.
- Awogbemi, O., & Akinbode, S. O. (2020). Post-harvest losses and food security in Nigeria. *Journal of Food Security*, 8(2), 59–66.
<https://doi.org/10.12691/jfs-8-2-4>
- Awosanmi, G. O., Afolayan, A. F., Perry, M., Ajibade, G. O., & Ajayi, S. A. (2024). Policy impacts in dynamic relation to food, income, learning and security: COVID-19 lockdowns in a Nigerian Agrarian Community. *Environment, Development and Sustainability*, 1–18.
- Doss, C., & Quisumbing, A. R. (2020). Understanding rural women’s access to assets and decision-making. *Journal of Development Studies*, 56(9), 1503–1517.
<https://doi.org/10.1080/00220388.2019.1702980>
- Farnworth, C. R., Badstue, L., & Umantseva, A. (2020). Gender relations and agricultural innovation. *Outlook on Agriculture*, 49(1), 13–21.
<https://doi.org/10.1177/0030727019900760>
- Gao, Y., Zhao, T., Xu, X., & Ndidiamaka, A. P. (2023). Can agricultural protectionist policies help achieve food security in Nigeria? *Frontiers in Sustainable Food Systems*, 7, 1095914;
<https://doi.org/10.3389/fsufs.2023.1095914>
- Gaya H., Tegbaru A., Bamire A., Abdoulaye T., Kehinde A. (2017). Gender differentials and adoption of drought tolerant maize varieties among farmers in northern Nigeria. *European Journal of Business and Management*; 9(5)
- Meinzen-Dick, R., Rubin, D., Elias, M., Mulema, A. A., & Myers, E. (2019). Women’s empowerment in agriculture: Lessons from qualitative research (IFPRI Discussion Paper No. 01797). International Food Policy Research Institute.
<https://hdl.handle.net/10568/99534>
- Ogunniyi, A., Omonona, B. T., & Fagbemi, F. (2023). Rice production, policy, and food security outcomes in Nigeria. *Agricultural Economics*, 54(1), 77–91.
<https://doi.org/10.1111/agec.12756>
- Ojo, R. A., Afolayan, A. F., Owombo, P. T., Afelumo, B. E., & Ibitoye, B. G. (2025). Inferential analysis of the determinants of post-harvest losses in rice value chains: Evidence from Southwest Nigeria. *Journal of Applied Econometrics and Quantitative Methods*, 1(4), 1–14.
- Peterman, A., Behrman, J. A., & Quisumbing, A. R. (2014). A review of empirical evidence on gender differences in nonland agricultural inputs, technology, and services in developing countries. *Gender in agriculture: Closing the knowledge gap*, 145–186.
- Ragasa, C., Sengupta, D., Osorio, M., Ourabah, H., & Mathur, S. (2019). Gender and agricultural productivity: Implications for innovation systems. *World Development*, 115, 119–136.
<https://doi.org/10.1016/j.worlddev.2018.11.010>

Quisumbing, A. R., Rubin, D., Manfre, C., Waithanji, E., Van den Bold, M., Olney, D., ... & Meinzen-Dick, R. (2015). Gender, assets, and market-oriented agriculture: learning

from high-value crop and livestock projects in Africa and Asia. Agriculture and human values, 32(4), 705-725.