

Delivery and Effectiveness of Agricultural Extension Services among Fish Farmers in Lagos State, Nigeria

Samuel Awolumate ^{1*}, Sulaiman W. Ojuola ²

¹Department of Animal Science and Fisheries,
National Open University of Nigeria, Kaduna, Nigeria

²Department of Agricultural Extension and Rural Development,
National Open University of Nigeria, Lagos State, Nigeria

***Corresponding author:** sawolumate@noun.edu.ng

Abstract

Agricultural extension services play a critical role in enhancing productivity and sustainability in aquaculture systems. This study examined the delivery and effectiveness of agricultural extension services among fish farmers in Lagos State, Nigeria. Primary data were collected from 120 fish farmers using structured questionnaires. Descriptive statistics and multiple regression analysis were employed to analyse extension service delivery channels, access patterns, and determinants of extension service utilisation. The results showed that extension services are delivered through a pluralistic system involving public extension agents (40.8%), cooperative societies (36.7%), private consultants (22.7%), and ICT-based platforms (48.3%). Regression results indicate that education level ($\beta = 0.286$, $p < 0.01$), farming experience ($\beta = 0.241$, $p < 0.01$), farm size ($\beta = 0.119$, $p < 0.05$), and cooperative membership ($\beta = 0.312$, $p < 0.01$) significantly influence access to extension services, with the model explaining 41% of the variation ($R^2 = 0.41$). The study concludes that agricultural extension services are moderately effective but constrained by inadequate personnel, irregular visits, and poor funding. It recommends strengthening public extension systems, promoting ICT-based advisory services, and adopting blended extension approaches to improve service delivery and enhance aquaculture productivity in Lagos State.

Keywords: Agricultural extension, Aquaculture, Fish farmers, Extension service delivery, ICT-based extension, Cooperative membership, Lagos State, Nigeria

1.0 Introduction

Aquaculture has become an increasingly important component of food security, income generation, and employment in Nigeria, particularly in urban and peri-urban areas where demand for fish continues to rise (Ele *et al.*, 2013). Lagos State represents the largest fish consumption hub in the country, yet domestic production remains insufficient to meet

demand, resulting in significant reliance on imports (FAO, 2024; Mapfumo, 2022). Enhancing the productivity and sustainability of fish farming in such urban environments requires effective institutional support, among which agricultural extension services play a critical role.

Agricultural extension services facilitate the transfer of knowledge, innovations, and management practices from research institutions to farmers, thereby improving productivity and adoption of improved technologies (Abebe et al., 2025). In aquaculture, extension support is particularly important due to the technical nature of fish production systems, which require specialised knowledge in pond management, feeding regimes, disease control, and water quality management (Aromolaran et al., 2024). However, extension service delivery in Nigeria has been constrained by inadequate funding, shortage of personnel, weak logistics, and poor coordination among service providers (Okorie et al., 2024). These limitations have reduced the effectiveness of traditional public-sector extension systems in meeting the evolving needs of farmers.

In response to these challenges, recent studies have emphasised the emergence of pluralistic extension systems involving private advisory services, cooperatives, and ICT-based platforms (Blum et al., 2020; Khatri et al., 2024). These systems are increasingly recognised as complementary mechanisms for improving extension outreach and effectiveness, particularly in urban areas where physical access may be limited. Digital extension tools, including mobile phones and social media platforms, have been shown to enhance information dissemination and reduce spatial constraints in agricultural advisory services (World Bank, 2020). Despite these developments, most empirical studies on agricultural extension in Nigeria have largely focused on crop production systems—mainly indigenous staple tubers, vegetables and cereal crops in rural settings; because increase in their yield paves immediate response to food security needs; creating a limited attention to aquaculture and urban extension dynamics (Agwu et al., 2023; Daodu et al., 2025; Ben et al., 2024; Ekwere et al., 2023).

Furthermore, while existing studies have examined extension service delivery and technology adoption, there is still insufficient empirical evidence on how fish farmers in urban contexts access, utilise, and perceive the effectiveness of different extension delivery channels. In particular, the role of ICT-based extension in complementing conventional systems and the factors influencing farmers' access to extension services in densely populated urban environments such as Lagos State remain underexplored. This gap limits the development of targeted extension strategies that can effectively address the unique constraints faced by fish farmers operating in urban and peri-urban systems.

This study therefore contributes to the literature by providing empirical evidence on the delivery channels, perceived effectiveness, determinants of access, and constraints associated with agricultural extension services among fish farmers in Lagos State, Nigeria. Specifically, the study aimed to examine the structure of extension service delivery, evaluate the effectiveness of extension services across key production areas, identify the socio-economic factors influencing access to extension services, and analyse the major constraints affecting extension delivery. Focusing on aquaculture within an urban context will enable the study provide insights for designing more inclusive, efficient, and ICT-supported extension systems to enhance fish production and reduce dependence on imports.

2.0 Materials and Methods

2.1 Study Area

The study was conducted in Lagos State, Nigeria, a major hub of aquaculture production and fish marketing. Lagos State is located in the south-western geopolitical zone of Nigeria and lies between latitude 6°23'N and longitude 3°23'E. The state is characterised by a tropical climate with bimodal rainfall, extensive wetlands, lagoons, and coastal water bodies that support aquaculture activities.

The study specifically covered selected Local Government Areas (LGAs) with a high concentration of fish farming activities, including Ikorodu, Epe, and Badagry. These areas were purposively selected due to their prominence in aquaculture production and the presence of organised fish farmer groups. Fish farming in these areas is predominantly small- to medium-scale and largely market-oriented, supplying urban consumers within Lagos State.

2.2 Research Design

A cross-sectional survey research design was adopted for this study. This design was considered appropriate for collecting quantitative data on extension service delivery, access, and effectiveness among fish farmers at a single point in time, as well as for analysing relationships between socio-economic characteristics and access to extension services.

2.3 Sampling Procedure and Sample Size

A multi-stage sampling procedure was employed in selecting respondents for the study. In the first stage, three LGAs (Ikorodu, Epe, and Badagry) were purposively selected based on the intensity of aquaculture activities. In the second stage, fish farmers' associations and cooperative societies within the selected LGAs were identified and used as the sampling frame. In the final stage, individual fish farmers were randomly selected from the sampling frame using simple random sampling techniques.

A total of 120 fish farmers were selected and interviewed for the study. The sample size was considered adequate for statistical analysis and is consistent with similar studies in agricultural extension and aquaculture research.

2.4 Data Collection and Measurement of Variables

Primary data were collected using a structured questionnaire administered through face-to-face interviews. The questionnaire captured information on respondents' socio-economic characteristics, extension service delivery channels, access to extension services, perceived effectiveness of extension services, and constraints affecting extension delivery.

Access to agricultural extension services was treated as the dependent variable and was measured as a binary variable (1 = access to extension services, 0 = no access). Independent variables included age (years), level of education (years of schooling), farming experience (years), farm size (hectares), cooperative membership (dummy variable: 1 = member, 0 = non-member), and access to credit (dummy variable: 1 = access, 0 = no access).

Perceived effectiveness of extension services was measured using a five-point Likert scale (1 = very ineffective, 5 = very effective), while constraints to extension service delivery were also measured using Likert-scale responses and ranked based on mean scores.

2.5 Analytical Techniques

Data were analysed using descriptive statistics such as frequencies, percentages, means, and standard deviations to summarise respondents' characteristics and extension service delivery patterns.

Multiple regression analysis using the Ordinary Least Squares (OLS) technique was employed to examine the determinants of fish farmers' access to agricultural extension services. The choice of OLS regression is justified by its suitability for estimating linear relationships between a dependent variable and multiple explanatory variables, and its wide application in agricultural extension studies (Gujarati and Porter, 2009; Ikoyo-Eweto et al., 2023).

The regression model is specified as:

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \varepsilon \dots \dots \dots \text{Equation 2.1}$$

Where:

Y = Access to agricultural extension services

X₁ = Age of farmer (years)

X₂ = Level of education (years)

X₃ = Farming experience (years)

X₄ = Farm size (hectares)

X₅ = Cooperative membership (1 = yes, 0 = no)

X₆ = Access to credit (1 = yes, 0 = no)

β₀ = Intercept

β₁–β₆ = Regression coefficients

ε = Error term

All statistical analyses were conducted using the Statistical Package for Social Sciences (SPSS), version 25.

3.0 Results

3.1 Socio-Economic Characteristics of Fish Farmers

The socio-economic characteristics of fish farmers are presented in Table 3.1. The results indicate that fish farming in the study area is dominated by economically active individuals, with 42.7% of respondents aged between 30 and 39 years, followed by 39.3% aged 40 years and above. This age distribution suggests that fish farming is largely undertaken by individuals within the productive age group, which has positive implications for labour availability and technology adoption.

A high level of formal education was observed among respondents, with 54.0% having tertiary education and 32.0% having secondary education. Antia-Obong *et al.*, (2021) found similar high levels of formal education in a study on poultry farmers suggesting that a high

level of formal education may exist among farmers engaged in animal husbandry perhaps due to the complexities of raising animals. In addition, this relatively high educational attainment enhances farmers' ability to access, interpret, and utilise extension information effectively. Furthermore, 62.3% of respondents were members of cooperative societies, indicating the importance of social networks in facilitating access to information and extension services.

Table 3.1: Socio-economic Characteristics of Fish Farmers in Lagos State (n = 120)

Variable	Category	Frequency (n)	Percentage (%)
Sex	Male	77	64.0
	Female	43	36.0
Age (years)	< 30	22	18.0
	30–39	51	42.7
	≥ 40	47	39.3
Education level	Primary	17	14.0
	Secondary	38	32.0
	Tertiary	65	54.0
Cooperative membership	Member	75	62.3
	Non-member	45	37.7

3.2 Extension Service Delivery Channels

Table 3.2 presents the extension service delivery channels utilised by fish farmers. The findings reveal a pluralistic extension system, where multiple actors contribute to service delivery. Public extension agents accounted for 40.8% of service delivery, while cooperative societies contributed 36.7%. Notably, ICT-based platforms were the most frequently utilised channel (48.3%), indicating a growing reliance on digital tools for accessing extension information.

The prominence of ICT-based extension suggests that fish farmers are increasingly adopting digital platforms to overcome the limitations associated with traditional extension systems, such as limited personnel and irregular visits. This highlights the potential of ICT-enabled advisory services in improving extension outreach in urban aquaculture systems.

Table 3.2: Extension Service Delivery Channels Utilised by Fish Farmers

Extension Channel	Frequency (n)	Percentage (%)
Public extension agents	49	40.8
Cooperative societies	44	36.7
Private consultants	27	22.7
ICT-based platforms*	58	48.3

Note: Multiple responses were allowed

3.3 Perceived Effectiveness of Agricultural Extension Services

The perceived effectiveness of extension services is presented in Table 3.3. The results show that extension services were generally rated as moderately effective, with higher mean scores recorded for technical knowledge improvement (mean = 3.82) and pond management practices (mean = 3.71). These findings indicate that extension services are relatively effective in enhancing core production practices among fish farmers.

However, lower mean scores were observed for marketing information (mean = 3.21) and access to finance information (mean = 3.08), suggesting that extension services are less effective in addressing value chain and financial aspects of fish farming. This imbalance implies that extension delivery remains largely production-oriented, with limited emphasis on market integration and enterprise development.

Table 3.3: Perceived Effectiveness of Agricultural Extension Services

Extension Outcome	Mean Score	Interpretation
Technical knowledge improvement	3.82	Effective
Pond management practices	3.71	Effective
Disease control	3.65	Moderate
Feed management	3.58	Moderate
Marketing information	3.21	Moderate
Access to finance information	3.08	Moderate

Scale: 1 = Very Ineffective, 5 = Very Effective

3.4 Determinants of Access to Agricultural Extension Services

The regression results presented in Table 4 show that the explanatory variables jointly explain 41% ($R^2 = 0.41$) of the variation in fish farmers' access to extension services, indicating a moderate explanatory power of the model. The model is statistically significant, suggesting that the included variables are relevant in explaining access to extension services.

Education level has a positive and statistically significant effect ($\beta = 0.286$, $p < 0.01$), indicating that more educated farmers are more likely to access extension services. This may be attributed to their greater awareness and ability to engage with extension providers. Similarly, farming experience ($\beta = 0.241$, $p < 0.01$) positively influences access, suggesting that experienced farmers are better positioned to seek and utilise extension services.

Farm size also has a positive and significant effect ($\beta = 0.119$, $p < 0.05$), implying that larger-scale farmers have greater interaction with extension systems, possibly due to higher investment stakes. Cooperative membership ($\beta = 0.312$, $p < 0.01$) emerges as one of the strongest determinants, highlighting the critical role of farmer organisations in facilitating access to extension information and services.

In contrast, age and access to credit were not statistically significant, suggesting that these factors do not play a major role in determining access to extension services in the study area. Overall, the results indicate that human capital (education, experience) and social capital (cooperative membership) are key drivers of extension access.

Table 3.4: Regression Results for Determinants of Access to Extension Services

Variable	Coefficient (β)	Std. Error	t-value
Constant	0.914	0.213	4.29***
Age	-0.042	0.038	-1.11
Education level	0.286	0.071	4.03***
Farming experience	0.241	0.064	3.77***
Farm size	0.119	0.052	2.29**
Cooperative membership	0.312	0.083	3.76***
Access to credit	0.098	0.061	1.61

3.5 Constraints to Extension Service Delivery

The major constraints affecting extension service delivery are presented in Table 3.5. The results indicate that inadequate extension personnel (mean = 4.31), irregular extension visits (mean = 4.18), and poor funding (mean = 4.05) are the most severe constraints.

These findings suggest that structural limitations within the extension system significantly hinder effective service delivery. The high ranking of these constraints explains the increasing reliance on alternative channels such as ICT-based platforms. Other constraints, including limited training materials (mean = 3.74) and poor feedback mechanisms (mean = 3.61), further highlight gaps in the extension delivery system that may reduce the effectiveness of advisory services.

Table 3.5: Constraints to Extension Service Delivery

Constraint	Mean Score	Rank
Inadequate extension personnel	4.31	1st
Irregular extension visits	4.18	2nd
Poor funding	4.05	3rd
Limited training materials	3.74	4th
Poor feedback mechanisms	3.61	5th

4.0 Discussion

The findings of this study provide important insights into the structure, effectiveness, and constraints of agricultural extension services among fish farmers in Lagos State. The socio-economic characteristics of respondents indicate that fish farming is largely undertaken by individuals within the economically active age group, with a relatively high level of formal education. This aligns with the findings of Akinboye (2024) and Daodu et al. (2025), who reported that higher educational attainment enhances farmers' capacity to access and utilise extension information effectively. Similarly, the high level of cooperative membership observed in this study supports the argument by Adu et al. (2024) that farmer organisations serve as critical platforms for information dissemination and collective access to extension services.

The results on extension delivery channels reveal the existence of a pluralistic extension system involving public extension agents, cooperatives, private consultants, and ICT-based platforms. The prominence of ICT-based platforms in this study corroborates the findings of Khatri et al. (2024) and Blum et al. (2020), who emphasised the growing role of digital technologies in complementing conventional extension systems. However, this finding contrasts with earlier studies such as Ogunniyi et al. (2021), which reported limited adoption of ICT tools among farmers due to low digital literacy. The difference may be attributed to the urban context of Lagos State, where access to mobile technologies and internet services is relatively higher.

With respect to effectiveness, extension services were found to be more impactful in improving technical knowledge and production-related practices than in marketing and financial aspects. This result is consistent with the findings of Akinwale and Adeyemo (2022), who observed that extension services in Nigeria are largely production-oriented, with limited emphasis on value chain development. However, it differs from the findings of Belton

et al. (2021), who reported more balanced extension impacts across production and market functions in Asian aquaculture systems. The disparity may reflect differences in institutional capacity and the level of private sector participation in extension delivery.

The regression results further highlight the importance of human and social capital in determining access to extension services. The positive and significant effects of education level and farming experience are consistent with the findings of Gebremariam et al. (2021) and Ikoyo-Eweto et al. (2023), who reported that educated and experienced farmers are more likely to access and utilise extension services effectively. The strong influence of cooperative membership also supports the findings of Adu et al. (2024), which emphasised the role of farmer organisations in facilitating extension access and reducing information asymmetry. In contrast, the insignificance of age observed in this study disagrees with the findings of Ibrahim et al. (2023), who reported age as a significant determinant of extension access in rural farming systems. This difference may be explained by the relatively homogeneous age distribution of respondents and the urban nature of the study area.

The constraints identified in this study point to persistent institutional weaknesses within the extension system. The ranking of inadequate extension personnel, irregular visits, and poor funding as the most severe challenges is consistent with the findings of Okorie et al. (2024) and FAO (2024), which identified similar structural constraints in extension systems across developing countries. These limitations explain the increasing reliance on ICT-based platforms as alternative sources of information. However, while digital extension offers significant potential, it may not fully substitute for face-to-face advisory services, particularly for farmers with limited digital literacy. This supports the argument by Jellason et al. (2025) that blended extension approaches combining conventional and digital systems are more effective in improving agricultural outcomes.

The findings suggest that improving agricultural extension services for fish farmers in Lagos State requires a multi-dimensional strategy. Strengthening public extension capacity, promoting ICT integration, and leveraging farmer organisations as institutional platforms are essential for enhancing extension effectiveness. In addition, expanding extension services beyond production to include marketing, financial management, and value chain development is critical for improving the overall performance and sustainability of aquaculture enterprises in urban contexts.

5.0 Conclusion and Recommendations

5.1 Conclusion

This study examined the delivery and effectiveness of agricultural extension services among fish farmers in Lagos State, Nigeria. The findings reveal that extension service delivery operates within a pluralistic framework involving public extension agents, cooperative societies, private consultants, and ICT-based platforms. Among these, digital channels have emerged as the most frequently utilised, reflecting a shift towards technology-driven extension systems in response to structural limitations in conventional service delivery.

The study further shows that extension services are moderately effective, with stronger impacts observed in technical knowledge dissemination and production-related practices such as pond management and disease control. However, their limited effectiveness in marketing

and financial advisory services highlights a critical gap in the current extension system, which remains largely production-oriented.

Empirical evidence from the regression analysis indicates that education level, farming experience, farm size, and cooperative membership significantly influence fish farmers' access to extension services. These findings underscore the importance of human capital and social organisation in enhancing extension utilisation. At the same time, the study identifies persistent institutional challenges, including inadequate extension personnel, irregular extension visits, and poor funding, which constrain effective service delivery.

The findings demonstrate that while agricultural extension services play a vital role in supporting fish farming in Lagos State, their effectiveness is limited by structural and institutional constraints. Addressing these challenges is essential for improving aquaculture productivity, enhancing farmers' livelihoods, and reducing dependence on fish imports.

5.2 Recommendations

Based on the findings of this study, the following recommendations are proposed:

1. Government and relevant agencies should increase investment in extension services through improved funding, recruitment, and continuous training of extension personnel, with specific emphasis on aquaculture-related competencies.
2. There is a need to expand and institutionalise the use of ICT-based extension tools, including mobile applications, social media platforms, and digital advisory services, to complement conventional extension delivery, particularly in urban and peri-urban areas.
3. A hybrid extension model that combines face-to-face advisory services with digital platforms should be promoted to ensure inclusiveness and effectiveness, especially for farmers with varying levels of digital literacy.
4. Cooperative societies and farmer groups should be strengthened and actively integrated into extension delivery systems, as they serve as critical platforms for information dissemination, collective learning, and improved access to extension services.
5. Extension programmes should go beyond production-focused advisory services to include marketing, financial management, and value chain development in order to enhance the profitability and sustainability of fish farming enterprises.
6. Efforts should be made to address key institutional challenges such as inadequate staffing, irregular extension visits, and poor funding through improved policy support, monitoring, and coordination among extension service providers.

5.3 Limitations of the Study

This study is limited by its cross-sectional design, which captures extension service delivery and effectiveness at a single point in time. Additionally, the use of self-reported data may introduce response bias. Future studies could adopt longitudinal approaches and incorporate objective performance measures to provide deeper insights into the impact of extension services.

5.4 Areas for Further Research

Further research is recommended to explore the long-term impact of ICT-based extension systems on aquaculture productivity, as well as comparative analyses of extension delivery models across different regions. Studies focusing on the integration of extension services with market and financial systems would also provide valuable insights for strengthening agricultural value chains.

References

- Adebayo, A. A. and Adeola, R. G. (2021). Market integration and price transmission in Nigerian agricultural markets. *Nigerian Journal of Agricultural Economics*, 11(2): 45–58.
- Adeoye, I. B. (2024). Information access and efficiency in fish marketing systems in Nigeria. *African Journal of Agricultural Research*, 19(3): 215–224.
- Adu, E. O., Mensah, P. and Boateng, K. (2024). Farmer organisations and access to agricultural extension services in sub-Saharan Africa. *Journal of Rural Studies*, 98: 112–121.
- Aker, J. C. (2010). Information from markets near and far: Mobile phones and agricultural markets in Niger. *American Economic Journal: Applied Economics*, 2(3): 46–59.
- Aker, J. C. and Fafchamps, M. (2015). Mobile phone coverage and producer markets: Evidence from West Africa. *World Bank Economic Review*, 29(2): 262–292.
- Akinboye, O. A. (2024). Education and access to agricultural extension services among smallholder farmers in Nigeria. *Journal of Agricultural Extension*, 28(1): 34–45.
- Akinwale, A. A. and Adeyemo, R. (2022). Effectiveness of agricultural extension services in improving farm productivity in Nigeria. *Nigerian Journal of Agricultural Economics*, 12(1): 56–68.
- Antia-Obong, E. A., Hubbard, C., and Garrod, G. (2021). Influence of transaction costs on smallholder poultry market participation in Nigeria: A mixed-methods analysis. *World Food Policy*, 7(2), 96-110. <https://doi.org/10.1002/wfp2.12028>
- Belton, B., Reardon, T. and Zilberman, D. (2021). Sustainable intensification of aquaculture value chains in developing countries. *World Development*, 144: 105–120.
- Ben, F. E., Udounang, P. I., Efretuei, A. O., Ekwere, O. J., & Effiong, J. F. (2024). Improving Biomass Yield and Root Production in Sweetpotato using Vine Cuttings from Different Plant Sections. *AKSU Journal of Agriculture and Food Sciences*, 8(3), 1-8.

- Blum, M. L., Cofini, F. and Sulaiman, R. V. (2020). Agricultural extension in transition worldwide: Policies and strategies for reform. *Global Food Security*, 26: 100–115.
- Daodu, A. A., Adegbite, O. O. and Akinola, O. A. (2025). Socio-economic determinants of farmers' access to extension services in Nigeria. *Journal of Agricultural Development Studies*, 14(2): 88–99.
- Ekwere, O., A. O Efretuei, P. I Udounang, F. E Akpaninyang (2023). Evaluation of some growth and yield traits of nine cultivars of white guinea yam (*Dioscorea rotundata* Poir.). *AKSU Journal of Agriculture and Food Sciences*. 7 (2) 83-96
- Ele, Ideba E., Ibok, Otu W., Antia-Obong, Essien A., Okon, Iniobong E. and Udoh, Ekaette S. (2013). Economic Analysis of Fish Farming in Calabar, Cross River State, Nigeria. *Greener Journal of Agricultural Sciences*, 3(7): 542-549.
- FAO (2023). The state of world fisheries and aquaculture 2023. Rome: Food and Agriculture Organization of the United Nations.
- FAO (2024). Fishery and aquaculture country profiles: Nigeria. Rome: Food and Agriculture Organization of the United Nations.
- Garku, E. (2008). Market information systems and price formation in developing countries. *Journal of Development Studies*, 44(5): 685–702.
- Gebremariam, H., Tesfaye, W. and Bekele, S. (2021). Determinants of access to agricultural extension services among smallholder farmers. *Agricultural Economics Review*, 22(1): 67–78.
- Ibrahim, M. A., Sani, R. and Yusuf, A. (2023). Factors influencing farmers' access to agricultural extension services in rural Nigeria. *Journal of Agricultural Policy*, 9(1): 21–32.
- Ikoyo-Eweto, G., Ajayi, M. T. and Ogunleye, A. S. (2023). Socio-economic factors influencing access to agricultural extension services in Nigeria. *Journal of Agricultural Economics and Extension*, 18(2): 75–86.
- Jellason, N. P., Robinson, E. J. Z. and Ogbaga, C. C. (2025). Blended extension approaches and agricultural productivity in developing countries. *Agricultural Systems*, 210: 103–115.
- Jensen, R. (2007). The digital provider: Information (technology), market performance, and welfare in the South Indian fisheries sector. *Quarterly Journal of Economics*, 122(3): 879–924.
- Khatri, S., Babu, S. and Joshi, P. K. (2024). Digital extension and agricultural transformation in developing economies. *Food Policy*, 120: 102–110.

- Minten, B., Tamru, S. and Engida, E. (2016). Transforming staple food value chains in Africa: The case of teff in Ethiopia. *Journal of Development Studies*, 52(5): 627–645.
- Ogunniyi, A. I., Olagunju, K. O. and Adeyemi, O. (2021). Adoption of ICT tools among farmers in Nigeria: Implications for extension service delivery. *Information Development*, 37(4): 620–631.
- Ogunremi, J. B., Adeola, R. G. and Salami, A. O. (2022). Information flow and marketing efficiency among fish traders in southwestern Nigeria. *Nigerian Journal of Fisheries*, 19(1): 101–112.
- Okorie, F. C., Ezech, C. I. and Okeke, M. I. (2024). Challenges of agricultural extension service delivery in Nigeria. *Journal of Agricultural Extension and Rural Development*, 16(2): 45–54.
- Timmer, C. P. (2017). Food security, structural transformation, and economic growth: A macroeconomic perspective. *Agricultural Economics*, 48(S1): 15–27.
- World Bank (2020). Digital agriculture: Opportunities and challenges in developing countries. Washington, DC: World Bank.