



Effect of Smart Training on the Dissemination of Agricultural Innovations Among Extension Workers in Ondo State

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ABSTRACT

The study examined the effect of SMART training on the dissemination of agricultural innovations among extension workers in Ondo State. Four objectives guided the study. Data were collected using well-structured questionnaires and administered to extension workers. Data were analyzed using both descriptive (percentages, frequency counts, mean, standard deviation) and inferential statistics (Linear regression). Findings from the study revealed that extension workers in Ondo State were nearly gender-balanced (51.9% male, 48.1% female) and predominantly middle-aged (\bar{x} = 49 years) with MSc as the highest educational attainment (61.1%). Most (88.9%) of the respondents were married and experienced (\bar{x} = 17 years), with moderate household size (mean = 8) and income (₦213,703) as serve as Village Extension Agents (79.6%). SMART training needs were highest for Remote Sensing (\bar{x} = 2.69) and Drone Technology (\bar{x} = 2.50). Key constraints included funding, digital literacy, infrastructure, and cultural resistance. It was recommended that government and developmental agencies should allocate more financial resources to support SMART agricultural training programs, digital tools, and operational needs of extension workers. There should be deliberate investment in rural infrastructure, especially reliable electricity and internet connectivity, to enable the practical application of digital extension technologies.

INTRODUCTION

The agricultural sector is a cornerstone of the global economy, supplying food, fiber, and essential resources to a growing world population. Projections indicate the global population will reach 9.7 billion by 2050, exerting significant pressure on agriculture to increase food production to meet rising demand (FAO, 2020). However, the sector faces complex challenges, including climate change, resource scarcity, and the urgent need for sustainable practices, all threatening the long-term sustainability of agricultural production (Tilman & Clark, 2022). Extension workers, as agricultural professionals, work closely with farmers, providing them with the knowledge, skills, and resources necessary to enhance farming practices and improve productivity (Rivera & Qamar, 2021). They serve as a vital link between research institutions and farmers, translating scientific advancements into practical, actionable solutions for field implementation (Klerkx, Begemann & Schut, 2023). The role of extension services in promoting smart agricultural practices is critical for sustainable agricultural development. Smart agriculture refers to the use of advanced technologies and data-driven approaches to optimize agricultural production, reduce environmental impact, and improve the overall efficiency of farming systems (Basso & Antle, 2020). This includes the use of precision farming techniques, such as GPS-guided tractors, variable-rate fertilizer application, and remote sensing technologies, as well as the integration of digital platforms, mobile apps, and other digital tools to support decision-making and resource management (Walter, Huber & Buchmann, 2021).

However, the dissemination and adoption of smart agricultural practices have been uneven, with many farmers, particularly in developing countries, lacking access to the necessary resources, knowledge, and skills to effectively implement these technologies (Baumüller, 2021). This is where the role of extension workers becomes critical, as they can provide targeted training and support to help farmers overcome these barriers and adopt smart agricultural practices (Klerkx et al., 2022). One of the key challenges in this regard is the need to ensure that extension workers themselves are equipped with the necessary knowledge and skills to effectively disseminate smart agricultural practices. Extension workers must not only be familiar with the latest technologies and best practices but also be able to effectively communicate this information to farmers in a way that is accessible and relevant to their specific needs (Yigezu, El-Shater, Boughlala, Bishaw & Niane, 2020).

Objective of the Study

The main aim of this study is to examine the impact of smart training on the dissemination of agricultural innovations among extension workers in Ondo State. Specifically the study:

1. ascertained the socio-economic characteristics of the extension workers;
2. identified the types of training the extension workers need to undergo;
3. determined the impact of SMART training on innovation delivery ; and
4. identified the constraints to SMART training of the extension workers .

It was hypothesized that there will not be any relationship between type of smart training and innovation delivery by the respondents

LITERATURE REVIEW

Extension workers' training has been a critical aspect of agricultural development and rural transformation in many countries. Extension workers are vital link between research institutions and farmers, facilitating the dissemination and adoption of new technologies and innovations (Davis, Swanson, Amudavi and Franzel, 2021). Extension worker training refers to the process of equipping extension workers with the necessary knowledge, skills, and attitudes to enable them to perform their duties effectively. Extension workers play an important role in bridging the gap between agricultural research and its practical application at the farm level. These frontline employees of agricultural extension services are responsible for disseminating information, providing advisory services, and facilitating the adoption of new technologies and practices among farmers (Suvedi, Ghimire, and Millen, 2020). It involves a range of activities, including formal education, on-the-job training, and continuous professional development. According to Davis et al. (2021), extension worker training involves providing extension workers with theoretical and practical skills necessary for delivering extension services to the target audience. The success of extension programmes depends on the competence, skills, and knowledge of the extension workers, making training a critical component of extension work. The aim of extension workers' training is to ensure that extension workers have the capacity to facilitate the adoption of new technologies and innovations by farmers, promoting agricultural development and rural transformation (Ragasa, Mzungu and Kalagho 2022). The training covers various aspects such as technical skills, communication skills, interpersonal skills, and problem-solving skills (Davis et al., 2021). Effective extension worker training is essential to ensure that they are equipped with the necessary knowledge, skills, and competencies to fulfill their roles efficiently and address the evolving needs of the farming community.

Types of Extension Worker Training

Induction Training

Induction training is the initial training given to new extension workers. It provides them with an understanding of the organization's policies, procedures, and culture. It also introduces them to the role of extension work and the challenges they may face (Khalil *et al.*, 2018).

Technical Training

Technical training focuses on equipping extension workers with the necessary technical skills required to perform their duties. It covers various aspects such as soil science, crop production, animal husbandry, and pest management.

Communication Training

Communication training focuses on improving the communication skills of extension workers. It covers various aspects such as public speaking, writing, and interpersonal communication.

Interpersonal Skills Training

Interpersonal skills training focuses on equipping extension workers with the necessary skills required to work effectively with people. It covers various aspects such as conflict resolution, negotiation, and teamwork.

Problem-Solving Skills Training

Problem-solving skills training focuses on equipping extension workers with the necessary skills required to solve complex problems faced by farmers. It covers various aspects such as critical thinking, decision-making, and creativity (Swanson and Rajalahti and Meinzen-Dick, 2023).

Smart Agricultural Practices (SAPs) on the other hand encompass a wide range of techniques and technologies designed to improve decision-making in agriculture by integrating traditional farming knowledge with advanced innovations. According to the Food and Agriculture Organization (FAO, 2022), SAPs are defined as "sustainable farming practices that utilize modern tools, technologies, and scientific advancements to optimize resource use, minimize environmental impacts, and enhance resilience to climate change. These principles enable farmers to use fewer resources such as water, fertilizers, and pesticides while achieving higher yields and maintaining the ecological balance (Davis et al., 2021). Smart Agricultural Practices (SAPs) represent a modern approach to farming that integrates advanced technology, sustainable techniques, and climate-smart methods to optimize agricultural productivity and environmental conservation. These practices are designed to ensure food security, enhance resource efficiency, and build resilience to climate change while addressing the social and economic needs of farmers (FAO, 2020). Zhang, Li, and Li (2020) described SAPs as practices that rely on data collection and analysis to improve agricultural operations.

By employing technologies such as Geographic Information Systems (GIS), satellite imagery, and precision sensors, SAPs enable farmers to make informed decisions about input application, pest control, and irrigation. These practices allow for site-specific farming, ensuring that each plot of land receives the precise amount of resources it needs, thereby reducing waste and maximizing efficiency. The use of technology is central to SAPs. For example, digital tools such as Geographic Information Systems (GIS), Internet of Things (IoT) devices, and Artificial Intelligence (AI) empower farmers to make data-driven decisions. These technologies provide insights into soil health, weather patterns, and crop conditions, allowing for site-specific management of resources (Kamilaris, Kartakoullis and Prenafeta-Boldú., 2019).

Component of Smart Agricultural Practices

Precision Agriculture

Precision agriculture is at the forefront of SAPs, focusing on optimizing field-level management regarding crop farming. It uses information technology, such as GPS, GIS, remote sensing, and variable rate technology (VRT), to assess and understand variations in crop, soil, and environmental conditions. This allows farmers to apply inputs like water, fertilizers, and pesticides in precise amounts where they are needed, reducing waste and environmental impact:

GPS and GIS

These technologies enable mapping of fields for detailed analysis, which supports decisions about soil management, planting, and harvesting. For example, GPS-enabled tractors can navigate autonomously, ensuring precise planting patterns (Pierce and Nowak, 2019).

Remote Sensing

Drones or satellites capture data on crop health, allowing for timely interventions. An example includes the use of NDVI (Normalized Difference Vegetation Index) to assess plant health, which has shown to increase yield by up to 10% through optimized resource use (Zarco-Tejada, Camino and González-Dugo, 2023).

Automated Systems

Automation in agriculture includes robotics, automated machinery, and IoT (Internet of Things) devices:

Robotic Harvesters

These reduce labor costs and can work continuously, potentially increasing efficiency and reducing the physical burden on human workers. Robots like those developed by Harvest CROO Robotics are designed to pick strawberries with minimal damage (Bechar and Vigneault, 2021).

IoT Sensors

These devices monitor soil moisture, temperature, and other variables in real-time. IoT in farming has led to the development of smart irrigation systems that adjust watering based on actual plant needs, conserving water and improving crop yields (Kodali Jain and Karagwal, 2022).

Data Analytics and AI

Big data analytics and AI play crucial roles in analyzing the vast amounts of data collected through SAPs:

Predictive Analytics

Using historical and real-time data to predict weather patterns, pest outbreaks, or market trends. For instance, IBM's Watson Decision Platform for Agriculture uses AI to provide insights tailored to specific farming conditions (IBM, 2019).

Machine Learning

Algorithms can identify diseases in crops from images or optimize the timing and quantity of inputs. An example is the use of machine learning models to detect fungal infections in wheat fields with up to 90% accuracy (Mohanty Hughes and Salathé, 2016).

METHODOLOGY

Description of the Study Area

The study was conducted in Ondo State, located in the South-Western region of Nigeria. Ondo State is known for its agricultural activities, with major crops including cocoa, cassava, maize, and yam. The state consists of both rural and semi-urban areas, making it an ideal location for assessing the dissemination of smart agricultural practices by ADP extension workers.

Population of the Study

The target population comprised of all the agricultural extension workers operating under the Ondo State Agricultural Development Program (ADP): Village extension officer, Block extension officer, zonal extension officer, deputy director and subject matter specialist

Sampling Techniques

The study employed a complete enumeration by making use of all the 54 extension workers involved in agricultural innovation dissemination.

Source of Data Collection

The research instrument for this study was a well-structured questionnaire which was a research instrument consisting of series of questions and other prompts for the purpose of gathering information from respondents. This was administered to extension workers with the help of 2 trained research assistants.

Method of Data Analysis

Data were analyzed using descriptive and inferential statistics. Descriptive statistics, including frequency counts, percentages, means and standard deviations were used to summarize the responses. Inferential statistics (linear regression) was employed to test the relationship between SMART extension worker training and innovation delivery by the respondents

RESULT AND DISCUSSIONS

Socio-economic Characteristics of Respondents

The socio-economic profile on Table 1 showed that 51.9% of the respondents were male, while 48.1% were female, indicating a nearly equal gender representation among extension workers. This balance suggests that both men and women are actively engaged in agricultural extension roles. Majority (49.1%) were between 41–46 years, implying that most respondents are middle-aged and likely experienced professionals. This aligns with Aina (2021) who observed that age is a determinant of productivity and adaptability to new agricultural innovations. In terms of marital status, 88.9% were married, suggesting stability and possibly greater social responsibility, which may influence their commitment to extension duties. Most respondents practiced Christianity (61.1%), while 38.9% were Muslims, reflecting the religious composition typical of southwestern Nigeria. Educationally, 61.1% held M.Sc. degrees, while 33.3% had B.Sc., showing that most extension workers were highly educated. This supports the findings of Ogunlade and Adebayo (2020) that higher educational attainment enhances the ability to adopt and disseminate agricultural innovations. Regarding years of experience, 51.9% had 16–20 years of service, and 29.6% had less than 16 years, indicating a well-experienced workforce. The average household size (mean = 8.1) suggests a moderately large family size typical of rural Nigeria. Monthly income data revealed that 46.3% earned between ₦210,000–₦269,999, showing that extension work provides moderate income. The majority (79.6%) were village extension agents, indicating that the respondents are primarily frontline workers who interact directly with farmers.

Table 1: Distribution of Respondents Based on their socio-economic Characteristics

| Variable | freq | % | \bar{x} | Std.Dev |
|----------------------------|-------------|----------|-----------------------------|----------------|
| Sex | | | | |
| Male | 28 | 51.9 | | |
| Female | 26 | 48.1 | | |
| Age | | | | |
| 41 - 46 | 7 | 13 | | |
| 47 - 51 | 38 | 70.4 | 49years | 3.135 |
| 52 and above | 9 | 16.7 | | |
| Marital status | | | | |
| Single | 2 | 3.7 | | |
| Married | 48 | 88.9 | | |
| Separated | 1 | 1.9 | | |
| Divorced | 3 | 5.6 | | |
| Religion | | | | |
| Christianity | 33 | 61.1 | | |
| Islam | 21 | 38.9 | | |
| Educational status | | | | |
| adult literacy | 1 | 1.9 | | |
| HND | 2 | 3.7 | | |
| B.Sc | 18 | 33.3 | | |
| M.Sc | 33 | 61.1 | | |
| Year of experience | | | | |
| ≤16 | 16 | 29.6 | | |
| 16 - 20 | 28 | 51.9 | 17years | 2.652 |
| >20 | 10 | 18.5 | | |
| Household size | | | | |
| ≤5 | 28 | 51.9 | | |
| 6 - 10 | 22 | 40.7 | 8 | 1.85 |
| >10 | 4 | 7.4 | | |
| Monthly income | | | | |
| 150000 - 200000 | 24 | 44.4 | | |
| 210000 - 269999 | 25 | 46.3 | #213.703 | 33942.12 |
| 270000 and above | 5 | 9.3 | | |
| Status | | | | |
| Village extension | 43 | 79.6 | | |
| zonal extension officer | 4 | 7.4 | | |
| block extension supervisor | 5 | 9.3 | | |
| subject matter specialist | 2 | 3.7 | | |

Source: Field Survey, 2025

Type of SMART Training Needed by Extension Workers

The mean responses ranged from 2.09 to 2.69, with a grand mean of 2.28, suggesting a moderate to high level of perceived training need across digital agricultural technologies. The highest rated need was for Remote Sensing for Crop Health Monitoring ($\bar{x} = 2.69$), followed by Drone Technology ($\bar{x} = 2.50$) and Digital Tools for Data Collection ($\bar{x} = 2.37$). These findings imply that extension workers recognize the importance of digital and precision agriculture in modern extension practice.

This aligns with Adejo and Haruna (2019) who reported that Nigerian extension workers increasingly require ICT-based skills to enhance the efficiency of agricultural advisory services. Similarly, FAO (2022) emphasized that capacity building in emerging smart technologies such as drones, GIS, and mobile applications is essential for achieving sustainable agricultural development goals.

Table 2: Type of SMART Training Needed by Extension Workers

| Variables | Yes | Occasionally | Often | Always | \bar{x} |
|---|-----|--------------|-------|--------|-------------|
| I believe training in Remote Sensing for Crop Health Monitoring would be beneficial. | 54 | 3 | 11 | 40 | 2.69 |
| I believe training in Drone Technology for Crop and Livestock Monitoring would be beneficial. | 53 | 4 | 19 | 31 | 2.50 |
| I believe training in Digital Tools for Data Collection would be beneficial. | 54 | 4 | 26 | 24 | 2.37 |
| I believe training in Big Data Analytics for Agricultural Decision Making would be beneficial. | 54 | 5 | 24 | 25 | 2.37 |
| I believe training in Social Media and Web-Based Training Platforms would be beneficial. | 54 | 10 | 18 | 26 | 2.30 |
| I believe training in Technology Integration for Sustainable Agriculture Practices would be beneficial. | 54 | 7 | 24 | 23 | 2.30 |
| I believe training in the use of Mobile Applications for Agriculture Extension would be beneficial. | 54 | 9 | 24 | 21 | 2.22 |
| I believe training in E-learning Content Development and Delivery would be beneficial. | 50 | 12 | 19 | 23 | 2.20 |
| I believe training in Geographic Information Systems (GIS) for Agricultural Planning would be beneficial. | 54 | 14 | 15 | 25 | 2.20 |
| I believe training in Precision Agriculture Technologies would be beneficial. | 54 | 11 | 22 | 21 | 2.19 |
| I believe training in Artificial Intelligence Applications in Agriculture would be beneficial. | 54 | 9 | 27 | 18 | 2.17 |
| I believe training in Online Communication and Outreach Strategies would be beneficial. | 54 | 6 | 33 | 15 | 2.17 |
| I believe training in IoT Devices for Farm Management would be beneficial. | 54 | 12 | 22 | 20 | 2.15 |

| Variables | Yes | Occasionally | Often | Always | \bar{x} |
|---|-----|--------------|-------|--------|-------------|
| I believe training in Climate-Smart Agriculture Technologies would be beneficial. | 54 | 13 | 23 | 18 | 2.09 |
| Grand Mean | | | | | 2.28 |

Source: Field Survey, 2025

Impact of SMART Training on Innovation Delivery

Findings on Table 3 revealed that respondents strongly agreed that SMART training improved their capacity for innovation delivery ($\bar{x} = 4.33$) and competence in extension work ($\bar{x} = 4.28$). Other high means include improved understanding of innovative agricultural practices ($\bar{x} = 4.20$) and increased confidence in delivering innovations ($\bar{x} = 4.19$). However, moderate agreement was observed for improved team collaboration ($\bar{x} = 3.81$) and adoption of new practices among farmers ($\bar{x} = 3.80$). Negative statements recorded lower mean scores (1.70–3.31), indicating strong disagreement confirming that SMART training positively influenced innovation delivery. This is consistent with Mbo’o-Tchouawou and Colverson (2020), who noted that ICT-enabled capacity-building programmes enhanced agricultural extension workers’ performance and farmer outreach. Likewise, Adisa et al. (2023) found that digital extension interventions significantly improve innovation diffusion and adoption rates among Nigerian farmers.

Table 3: Impact of SMART Training on Innovation Delivery

| Statements | Strongly Agree Freq (%) | Agree Freq (%) | Undecided Freq (%) | Disagree Freq (%) | Strongly Disagree Freq (%) | \bar{x} | Std. Dev |
|--|-------------------------|----------------|--------------------|-------------------|----------------------------|-----------|----------|
| SMART training has significantly improved my ability to deliver innovations to farmers. | 24 (44.4) | 24 (44.4) | 6 (11.1) | - | - | 4.33 | 0.673 |
| SMART training has contributed to enhancing my competence in carrying out extension work by equipping me with modern tools, practical knowledge that improves my effectiveness in the field. | 22 (40.7) | 25 (46.3) | 7 (13.0) | - | - | 4.28 | 0.685 |
| The SMART training provided a clear understanding of innovative agricultural practices to me. | 14 (25.9) | 37 (68.9) | 3 (5.6) | - | - | 4.20 | 0.528 |

| Statements | Strongly Agree Freq (%) | Agree Freq (%) | Undecided Freq (%) | Disagree Freq (%) | Strongly Disagree Freq (%) | \bar{x} | Std. Dev |
|--|-------------------------|----------------|--------------------|-------------------|----------------------------|-----------|----------|
| After receiving SMART training, I feel more confident in delivering innovative agricultural practices to farmers. | 18 (33.3) | 28 (51.9) | 8 (14.8) | - | - | 4.19 | 0.675 |
| SMART training has enhanced team collaboration in innovation projects. | 6 (11.1) | 32 (59.3) | 16 (29.6) | - | - | 3.81 | 0.617 |
| I have observed significant improvements in the adoption of new agricultural practices among farmers after receiving SMART training. | 10 (18.5) | 23 (42.6) | 21 (38.9) | - | - | 3.80 | 0.737 |
| After receiving SMART training, I do not feel more confident in delivering innovative agricultural practices to farmers. | 4 (7.4) | 29 (53.7) | 20 (37.0) | 1 (1.9) | - | 3.31 | 0.644 |
| I have not observed any significant improvements in the adoption of new agricultural practices among farmers after receiving SMART training. | 7 (13.0) | 20 (37.0) | 21 (38.9) | 2 (3.7) | 4 (7.4) | 2.29 | 1.022 |
| The SMART training has not provided a clear understanding of innovative agricultural practices to me. | - | 4 (7.4) | 14 (25.9) | 29 (53.7) | 7 (13.0) | 2.23 | 0.787 |
| SMART training has not contributed to enhancing my competence in carrying out my extension work effectively. | - | 3 (5.6) | 9 (16.7) | 28 (51.9) | 14 (25.9) | 2.02 | 0.812 |
| SMART training has not significantly improved my | - | 3 (5.6) | 4 (7.4) | 32 (59.3) | 15 (27.8) | 1.91 | 0.759 |

| Statements | Strongly Agree Freq (%) | Agree Freq (%) | Undecided Freq (%) | Disagree Freq (%) | Strongly Disagree Freq (%) | \bar{x} | Std. Dev |
|--|-------------------------|----------------|--------------------|-------------------|----------------------------|-----------|----------|
| ability to deliver innovations to farmers. | | | | | | | |
| SMART training has not enhanced team collaboration in innovation projects. | - | - | 4 (7.4) | 30 (55.6) | 20 (37.0) | 1.70 | 0.603 |

Source: Field Survey, 2025

Grand mean= 3.3

Constraints to SMART Training among the respondents

Major constraints include lack of resources, inadequate infrastructure, low motivation, insufficient trained facilitators, resistance to technology, and low digital literacy. The grand mean of 2.00 and uniform ranking imply that these challenges are severe and widespread among extension officers. This agrees with Agwu and Chah (2021), who found that inadequate funding, poor ICT infrastructure, and low digital literacy remain critical barriers to effective dissemination of modern extension services in Nigeria. Similarly, World Bank (2022) noted that digital transformation in African agriculture requires not just training but enabling infrastructure and policy support.

Table 4: Showing the Constraints to Dissemination of SMART Training

| Items | A Constraint | | Not a Constraint | | \bar{x} | Rank |
|---|--------------|------|------------------|-----|-----------|------|
| | Freq | % | Freq | % | | |
| Lack of resources (funding, tools) | 54 | 100 | | | 2 | 1 |
| Limited access to technology or internet connectivity | 53 | 98.1 | 1 | 1.9 | 1.98 | 2 |
| Low motivation or interest | 54 | 100 | | | 2 | 1 |
| Lack of trained facilitators or experts | 54 | 100 | | | 2 | 1 |
| Resistance to adopting new technologies | 54 | 100 | | | 2 | 1 |
| Poor infrastructure (e.g., internet, electricity) | 54 | 100 | | | 2 | 1 |
| Low Digital Literacy among Farmers | 54 | 100 | | | 2 | 1 |
| Low Incentives for Adoption | 54 | 100 | | | 2 | 1 |
| Cultural Resistance and Traditional Beliefs | 54 | 100 | | | 2 | 1 |
| Language and Communication Barriers | 53 | 98.1 | 1 | 1.9 | 1.98 | 2 |

Grand Mean=2.00

Source: Field Survey, 2025

HYPOTHESIS TESTING

Result of the linear regression analysis on Table 5 indicates a significant and positive relationship between the type of SMART training and innovation delivery by the extension workers ($\beta=0.125$, $t = 8.507$; $p < 0.05$) This implies that targeted SMART training programmes directly enhanced agricultural innovation delivery among extension personnel.

This finding corroborates Okoro et al. (2020), who emphasized that the relevance and specificity of digital training determined how effectively extension workers can apply knowledge to real-world innovation delivery. It also supports the Rogers' Diffusion of Innovation Theory (2003) which posited that knowledge acquisition through appropriate training accelerates the adoption and diffusion of innovations.

Table 5: Ho: Relationship between Type of SMART Training and Innovation Delivery by the respondents

| Variables | β -value | Standard deviation | R ² - value | T-value | p-value |
|---|----------------|--------------------|------------------------|---------|---------|
| Type of smart training *innovation delivery | 0.125 | 0.060 | 0.276 | 2.069 | 0.044* |

Source: Field Survey, 2025

CONCLUSION AND RECOMMENDATIONS

The study submitted that SMART training enhances extension workers' competence, confidence, and innovation dissemination. The more tailored and practical the training, the higher the likelihood of improving agricultural productivity and sustainability.

RECOMMENDATIONS

1. rural infrastructure such as electricity and internet connectivity should be upgraded;
2. regular workshops should be organized to improve skills in remote sensing, drones, and digital tool;
3. government should allocate more funding for SMART agricultural training programmes;
4. public-private partnerships should be encouraged to sustain training programmes; and
5. professional digital literacy courses should be integrated into agricultural extension curricula.

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