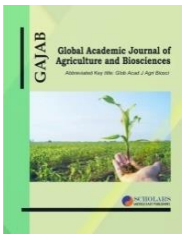
Global Academic Journal of Agriculture and Bio sciences

Available online at https://www.gajrc.com
DOI: https://doi.org/10.36348/gajab.2024.v06i06.004

OPEN ACCESS



ISSN:2706-8978 (P)
ISSN: 2707-2568 (O)

Original Research Article

Influence of Information and Communication Technology-Based Training on Livestock Production Efficiency in Bwari Area Council, Abuja

Ugochinyere Princess Eleke[1], Winifred Ifeoma Lai-Solarin[2], Joseph Bamidele[3], Oluwamayowa Joseph Joel[4], Ayoola Faith Joel[4], Samson Olayemi Sennuga[1*]

[1]Department of Agricultural Extension and Rural Sociology, Faculty of Agriculture, University of Abuja, FCT, P.M.B. 117, Abuja, Nigeria
[2]Federal Ministry of Agriculture and Food Security, Garki, Abuja, Nigeria
[3]Faculty of Business and Law, University of Northampton, Waterside Campus, University Drive, Northampton NN1 5PH, United Kingdom
[4]Communication for Development Centre, AMAC Estate, Airport Road, Abuja, Nigeria

***Corresponding Author**
Samson Olayemi Sennuga
Department of Agricultural Extension and Rural Sociology, Faculty of Agriculture, University of Abuja, FCT, P.M.B. 117, Abuja, Nigeria

Article History
Received: 19.10.2024
Accepted: 25.11.2024
Published: 27.11.2024

Abstract: This study examines the influence of ICT-based training on livestock production efficiency among farmers in Bwari Area Council, with a focus on socio-economic characteristics, ICT knowledge post-training, productivity impact, effectiveness factors, and preferred ICT tools. Using a multi-stage sampling approach, 250 livestock farmers were selected. Primary survey were collected and analyzed with descriptive and inferential statistics to meet the research objectives. The socio-economic analysis reveals a farming population primarily composed of middle-aged individuals (mean age 41.7 years), with 72% male and 64% married. Education levels varied, with 38% having secondary education. Post-training evaluations indicated that 80% of farmers were proficient in SMS alerts for disease management, 72% confident in mobile applications, and 70% experienced productivity gains using ICT tools. ICT training was found to positively impact areas like increasing awareness of government programs and subsidies (3.4), scheduling vaccinations accurately (3.3), disease prevention (3.2), and record-keeping (3.1) and feeding practices (3.0), preparing and storing livestock feeds (2.9), etc. Logit regression analysis identified significant factors influencing ICT effectiveness, including educational level ($p=0.010$), cooperative membership ($p = 0.012$), household size ($p=0.032$), contact with extension agents ($p=0.011$), and access to credit ($p = 0.002$), while gender, marital status, and farm size were non-significant. Kendall's Coefficient of Concordance analysis ranked mobile applications, SMS alerts, and radio broadcasts as the most effective ICT tools, demonstrating high consensus. Partnerships with telecommunication companies and government initiatives is recommended to address connectivity barriers, ensuring that all farmers can fully utilize digital tools in their livestock management practices.

Keywords: ICT, Training, Livestock, Production, Efficiency.

Citation: Ugochinyere Princess Eleke, Winifred Ifeoma Lai-Solarin, Joseph Bamidele, Oluwamayowa Joseph Joel, Ayoola Faith Joel, Samson Olayemi Sennuga (2024). Influence of Information and Communication Technology-Based Training on Livestock Production Efficiency in Bwari Area Council, Abuja, Glob Acad J Agri Biosci; Vol-6, Iss- 6 pp- 199-217.

INTRODUCTION

Livestock production plays an essential role in the economies of rural Nigerian communities, where it serves as a key income source, a means of food security, and a buffer against economic instability. This sector contributes significantly to Nigeria's agricultural GDP, supporting the livelihoods of millions of smallholder farmers who rely on livestock for financial and social sustenance (FAO, 2019). Despite its centrality to rural economies, livestock productivity in Nigeria faces a range of challenges, many of which stem from a lack of resources and access to essential knowledge on effective livestock management practices (Amole, Etim and Oludare, 2018; Olaitan *et al.,* 2024).

Smallholder farmers in remote regions are particularly disadvantaged, as they are often cut off from veterinary services, reliable feed supplies, and information on disease management and preventive care. This isolation contributes to persistent inefficiencies, with farmers relying on traditional, resource-intensive methods that frequently result in high mortality rates and limited yield. As a result, the sector's growth potential remains unrealized, and rural farmers struggle to increase productivity or adapt to modern, cost-effective livestock practices (Ogunniyi, Olu and Ojebiyi, 2020). In this context, Information and Communication Technology (ICT)-based training emerges as a promising intervention to address these knowledge and resource gaps, enabling farmers in remote areas to access relevant, practical information that could significantly improve livestock production and profitability (Sennuga *et al.,* 2024).

The application of ICT in agriculture, particularly in developing regions, has shown promising results in enhancing productivity, enabling sustainable practices, and supporting economic development (Aker and Mbiti, 2019; Amole *et al.,* 2018). In the livestock sector, ICT platforms offer a direct, accessible means for farmers to gain real-time information on critical aspects of livestock care, including animal health, feeding practices, breeding techniques, and disease prevention. Through these platforms, farmers can also access information on market trends and price fluctuations, allowing them to make informed decisions that positively affect both their yields and profits (Muriuki, Aklilu and Otieno, 2021). Various studies across sub-Saharan Africa, particularly in countries such as Kenya and Uganda, illustrate how ICT-based agricultural programs can lead to increased productivity, better resource allocation, and improved livestock health (Ogunniyi *et al*., 2020). In Kenya, for instance, mobile-based agricultural advisories have proven effective in reducing costs associated with livestock management, as farmers can quickly access expert guidance on disease prevention and resource use without needing to travel to extension service centers (Aker and Mbiti, 2019). Similar programs in Uganda have demonstrated the ability of ICT-based training to empower smallholder farmers with knowledge on feed optimization, health monitoring, and preventive care, leading to tangible improvements in productivity and reductions in livestock mortality rates. For rural Nigerian livestock farmers, who face similar constraints but have increasing access to mobile technology, ICT-based training represents an untapped resource for overcoming the traditional barriers of distance and limited access to expert advice (Lai-Solarin *et al.,* 2024).

Yet, despite the potential of ICT-based interventions to transform livestock farming, their implementation in rural Nigeria faces significant barriers that limit widespread adoption and impact (Oyediji *et al.,* 2024). Rural infrastructure gaps, particularly in internet and mobile network coverage, create challenges for consistently delivering ICT-based training to farmers in remote areas (World Bank, 2021). Although there have been considerable investments in expanding Nigeria's ICT infrastructure over the past decade, connectivity remains inconsistent in rural areas, where farmers struggle with unreliable or low-quality network service. Furthermore, digital devices like smartphones and tablets are often too costly for many smallholder farmers, who may have access to only basic mobile phones that lack the functionalities needed for more advanced ICT platforms (Oni, Ajayi and Adeoye, 2018).

Beyond issues of accessibility, there are also socio-cultural and educational challenges. Digital literacy levels are generally low in rural Nigeria, where a lack of familiarity with ICT tools makes it difficult for many farmers to fully utilize available resources or engage with mobile-based training content. Gender disparities further complicate ICT adoption, as women in rural areas, who make up a substantial portion of the agricultural workforce, frequently have less access to ICT devices and resources compared to their male counterparts (Adegbidi, Mensah, Vidogbena and Agboh-Noameshie, 2022). Addressing these multi-layered challenges requires strategic interventions that extend beyond technology provision alone. For ICT-based training programs to succeed, they must be designed to accommodate varying literacy levels, socio-cultural dynamics, and infrastructure limitations, ensuring that all community members, particularly marginalized groups, can benefit from the available technology (Odoh *et al.,* 2024).

Overcoming these barriers, however, holds transformative potential for rural Nigerian livestock

farming, offering pathways to enhanced productivity, improved livestock health, and greater economic resilience. By providing farmers with reliable, easily accessible information on best practices for disease prevention, breeding, and resource management, ICT platforms can help farmers reduce operational costs, minimize livestock losses, and increase their profitability (Oyediji *et al.,* 2024). For instance, if a farmer receives a timely SMS alert about a potential disease outbreak in the area, they can take preventive measures to protect their herd, a step that could significantly reduce mortality rates and safeguard their income. Similarly, when farmers have access to updated information on market prices, they can make informed choices about the timing of their sales, optimizing their returns and reducing the risks associated with market volatility (Muriuki *et al*., 2021).

Moreover, ICT-based training opens avenues for community building and peer-to-peer knowledge exchange, as farmers can connect with one another through digital platforms to share experiences, strategies, and advice. This type of collaborative learning not only enhances individual knowledge but also strengthens the overall resilience and productivity of the rural livestock sector. By reducing reliance on traditional, labour-intensive practices and promoting more sustainable and efficient approaches, ICT-based training could be a catalyst for broader socio-economic development within Nigeria's rural communities, contributing to national food security and poverty alleviation (Sennuga *et al.,* 2024).

In summary, the livestock sector in rural Nigeria remains a critical economic pillar, yet it faces enduring challenges that impede its productivity and efficiency. Limited access to veterinary care, a lack of updated knowledge on effective livestock management, and infrastructural constraints have prevented smallholder farmers from realizing the full potential of livestock farming. ICT-based training presents a compelling solution to these challenges by enabling farmers to access critical information and resources that can enhance their productivity, improve animal health, and strengthen their economic resilience (Iliyasu *et al.,* 2024). However, achieving the full impact of ICT-based interventions in this sector will require addressing practical obstacles, including network access, device affordability, and digital literacy gaps (Ameh *et al.,* 2024). By overcoming these barriers, ICT-based programs could deliver substantial benefits for rural livestock farmers, enhancing both their livelihoods and the broader stability of Nigeria's agricultural sector. This study aims to evaluate the influence of ICT-based training on livestock production efficiency in Bwari Area Council. To accomplish this, the following objectives are put forward to:

i. Investigate the socio-economic characteristics of livestock farmers undergoing ICT training in the study area.
ii. Evaluate the level of ICT knowledge among livestock farmers post-training in the study area.
iii. Assess the impact of ICT training on livestock production efficiency in the study area.
iv. Identify factors affecting the effectiveness of ICT training programs in the study area.
v. Rank the most effective ICT tools in enhancing livestock productivity in the study area.

LITERATURE REVIEW

Theoretical Framework

Rogers' Diffusion of Innovations Theory and its Application to ICT-Based Training in Livestock Production

Rogers' Diffusion of Innovations Theory (1962) provides a valuable framework for understanding how new ideas, practices, or technologies are adopted within a community over time. According to Rogers, the adoption process is influenced by several key factors: the perceived relative advantage of the innovation, its compatibility with existing practices, its complexity (or simplicity), its trialability, and the observability of its results. These factors shape whether and how quickly individuals within a social system will accept and integrate a new innovation. Applying this theory to ICT-based training in rural Nigerian livestock farming helps clarify the conditions under which such training might be effectively adopted and highlights potential strategies to enhance adoption and maximize impact.

In the context of ICT-based training for livestock production, relative advantage refers to the extent to which farmers perceive this digital approach as more beneficial than traditional, in-person methods or farming practices based on generational knowledge. Farmers are more likely to adopt ICT-based training if they believe it will lead to improved livestock health, higher productivity, reduced costs, or increased profitability. For example, if farmers see that ICT training provides them with timely information on disease prevention or market prices—information that would otherwise be unavailable to them due to geographical and infrastructural limitations—then the perceived advantage becomes clearer. Thus, a significant part of this study involves evaluating how ICT-based training demonstrates its value in concrete terms, such as better herd management, lower livestock mortality, and ultimately higher income for farmers.

Compatibility is another crucial factor, as it relates to how well ICT-based training aligns with the existing values, practices, and experiences of rural livestock farmers. For many farmers, livestock management practices have been passed down through generations, creating a strong cultural connection to traditional farming methods. ICT-based training, therefore, must be designed to integrate smoothly with these established practices and not appear as a complete overhaul of traditional techniques. For instance, if ICT training incorporates local knowledge and builds upon familiar concepts, farmers are more likely to view it as an enhancement rather than a replacement.

Complexity plays a role in the adoption of ICT-based training, as technologies perceived as overly complicated can deter adoption among rural farmers, especially if they lack digital literacy or experience with technology. Many rural Nigerian farmers may only have access to basic mobile devices, limiting their ability to engage with more sophisticated ICT platforms that require smartphones or internet access. By offering ICT training that leverages simple SMS alerts or local radio programs, for instance, the training can become more accessible and less intimidating for first-time users, encouraging broader acceptance and reducing the technological barrier to entry.

Conceptual Framework

The conceptual framework for this study, exploring the relationship between the independent variables and the dependent variable (related to the ICT-based training components and livestock production efficiency) being mediated by the intervening variables. The independent variables (socio-economic and institutional characteristics) in this study are factors that directly influence or mediate the effects of ICT training. The dependent variable in this study is defined as the represent the different facets of ICT-based training aimed at improving livestock production as well as livestock production efficiency, which represents the ultimate outcome that ICT-based training aims to improve. Livestock production efficiency encompasses several measurable outcomes, including improved livestock health, increased yield and productivity, higher farmer income and profit margins, etc. The intervening variables mediate the relationship between the independent variables and the dependent variable, either enhancing or impeding the effectiveness of ICT training and influencing production outcomes. These intervening variables help to explain why ICT-based training may have varied levels of effectiveness across different rural communities. They add nuance to the study by identifying conditions under which ICT training is likely to be more or less effective. The key intervening variables are: digital literacy levels, network infrastructure and connectivity, and peer influence and community support.

MATERIALS AND METHODS

Study Area

Bwari Area Council, located within the Federal Capital Territory (FCT) of Nigeria, serves as an insightful setting for examining the influence of ICT-based training on livestock production efficiency. Geographically, Bwari spans approximately 914 square kilometers and is situated in the northwestern region of the FCT, sharing borders with Kaduna State to the north. As a semi-urban and rural district, Bwari combines urban features in the town center with a predominantly rural landscape on its outskirts, making it representative of the socio-economic and infrastructural challenges faced by many Nigerian rural communities engaged in agriculture, particularly livestock farming (National Population Commission, 2006).

Livestock production in Bwari Area Council is a central part of the local economy, with a substantial portion of the population engaged in farming practices that include cattle, goats, poultry, and sheep rearing. For many residents, livestock farming provides a primary source of income and food security, underscoring the sector's importance for both economic stability and local sustenance. However, farmers in Bwari face significant challenges typical of rural Nigerian communities, including limited access to modern farming knowledge, inadequate veterinary services, and restricted availability of feed resources. These constraints lead to low productivity, increased livestock mortality, and inefficiencies that impact the economic well-being of the farming population. Additionally, while Bwari is part of the FCT and benefits from relatively better infrastructure than some more remote Nigerian regions, access to resources such as veterinary care and advanced agricultural training remains limited, particularly in the rural and semi-urban areas of the council (Aina and Ajayi, 2020).

Bwari's demographic and socio-economic profile make it an ideal location to study the effects of ICT-based training on livestock production. The area is home to a diverse mix of ethnic groups, including Gwari, Hausa, Fulani, and other indigenous communities, many of whom rely on traditional knowledge and practices in livestock farming. This demographic diversity introduces a range of cultural approaches to farming, providing a unique perspective on how ICT-based interventions can bridge the gap between traditional and modern agricultural methods (Victor and Samuel, 2021). Additionally, the recent expansion of mobile network coverage within the FCT, including in Bwari, has

made ICT-based solutions more feasible, even in rural areas where such technologies were previously inaccessible. Farmers are increasingly gaining access to mobile phones, although digital literacy levels vary widely, which may influence the effectiveness and adoption rates of ICT training programs. These dynamics provide a rich context for examining how factors like accessibility, digital literacy, and cultural relevance affect the uptake and impact of ICT-based training on livestock productivity (Bello and Adeyemi, 2023).

Population of the Study and Research Design

The population of this study comprises livestock farmers within the Bwari Area Council in the Federal Capital Territory (FCT) of Nigeria. Bwari has a diverse agricultural sector with a substantial number of smallholder farmers engaged in livestock rearing, including cattle, goats, poultry, and sheep. This demographic largely consists of rural and semi-urban residents who rely on livestock farming as a primary source of income and food security. The farmers in Bwari represent a mix of traditional practices and emerging openness to modern farming techniques, making them an ideal group for studying the impact of ICT-based training.

This study adopts a mixed-methods research design, combining both quantitative and qualitative approaches to capture a comprehensive view of how ICT-based training influences livestock production efficiency in Bwari Area Council. This design enables the study to quantify changes in production outcomes (e.g., yield, cost efficiency, and livestock health). The quantitative component of the study will use a quasi-experimental design with two groups: one group of livestock farmers who have access to ICT-based training and a control group with no access to such training. Surveys will be used to collect survey on specific production metrics, such as livestock mortality rates, productivity levels (e.g., milk yield, egg production), and operational costs. By comparing these metrics between the two groups, the study aims to assess whether and how ICT training contributes to improved livestock production efficiency. In the Qualitative Approach, we get to understand the social and contextual factors influencing the adoption of ICT-based training, the study will conduct semi-structured interviews and focus group discussions with a subset of livestock farmers. This approach allows for a more nuanced understanding of how ICT-based training affects day-to-day livestock management and decision-making processes, providing context to the quantitative results.

Sample Size and Sampling Techniques

For this study, a sample size of 250 livestock farmers from Bwari Area Council was selected to ensure robust statistical analysis and generalizability of findings to the larger population of livestock farmers in the area. Given the demographic and geographical diversity within Bwari, a multistage sampling technique will be employed. This approach allowed for a structured selection of participants across various regions and farming types, ensuring that the sample represents the broader characteristics of Bwari's rural and semi-urban livestock farming communities.

In the first stage, the study used cluster sampling to identify clusters based on communities or wards within Bwari, as these are the primary administrative units in the area. This stage ensured representation from both rural and semi-urban locations where livestock farming activities are concentrated. Major communities in Bwari Area Council include Bwari Town, Ushafa, Dutse Alhaji, Kubwa, and Igu. From these, a subset of communities was randomly selected to capture the geographic and socio-economic diversity within Bwari. Random selection at this stage allowed all communities in Bwari an equal chance of being included in the study, minimizing sampling bias and enhancing the representativeness of the sample.

In the second stage, a stratified sampling approach was applied within each selected community, categorizing farmers based on the type of livestock they rear, such as cattle, poultry, goats, and sheep. Stratifying by livestock type ensures that the sample accurately reflects the variety of livestock production in Bwari and allowed the study to explore whether ICT-based training impacts different livestock categories uniquely. By selecting a proportional number of respondents from each livestock stratum (e.g., cattle farmers, poultry farmers), the study ensured that each type of livestock farming is adequately represented. This approach not only captures the different livestock management practices within Bwari but also ensured that findings can be generalized across livestock types.

In the third stage, individual farmers within each category were randomly selected to participate in the study, with a goal of reaching 250 respondents overall. At this stage, a list of farmers from each selected community was generated, using community records, agricultural cooperatives, or local extension services where available. Random selection at the individual level further reduced potential bias and enhances the reliability of the study findings. Each community and livestock type contributed to the sample in proportion to its representation in Bwari's farming population. For instance, if livestock farming is more prevalent in Bwari Town than in Ushafa, a greater number of respondents will be drawn from Bwari Town.

Similarly, if poultry farming is more common than cattle farming, the sample will include more poultry farmers to accurately reflect the area's livestock farming composition.

Survey Collection

The primary survey collection instrument for this study was a structured questionnaire tailored to gather comprehensive information from livestock farmers in Bwari Area Council. This questionnaire was administered to a representative sample of farmers, with each session lasting approximately one hour, allowing respondents sufficient time to provide in-depth and accurate answers. To ensure both the validity and reliability of the questionnaire, it underwent a pre-testing phase through a pilot study. This pilot was conducted with a small group of livestock farmers who were not part of the main study, allowing the research team to identify and address any ambiguities or issues in the questionnaire's design. Feedback from the pilot phase led to necessary adjustments, refining the questions to enhance clarity, relevance, and effectiveness in capturing survey pertinent to the study's objectives. This process helped ensure that the final questionnaire was well-suited to collecting detailed insights into the challenges and benefits associated with ICT-based training for livestock production. Additionally, trained enumerators administered the questionnaire to help respondents clearly understand each question and to promote accuracy in their responses.

Survey Analysis

The survey collected for this study were analyzed using a combination of descriptive and inferential statistical methods, tailored to address each research objective effectively. Descriptive statistics—including percentages, frequency counts, and mean values—were utilized to address the first two objectives: investigating the socio-economic background of livestock farmers undergoing ICT training and evaluating the level of ICT knowledge among farmers post-training. These methods provided an overview of the sample's demographic and knowledge profiles.

For the third objective, which assesses the impact of ICT training on livestock production efficiency, a 4-point Likert scale was applied to evaluate participant responses. This scale enabled the study to capture and analyze respondents' perceptions of ICT training outcomes in a structured manner. To address the fourth objective—identifying factors that influence the effectiveness of ICT training—a logit regression model was employed to reveal significant relationships between various factors and the perceived effectiveness of the ICT training programs. Lastly, to achieve the fifth objective, Kendall's Coefficient of Concordance (W) were used to determine the most effective ICT tools in enhancing livestock productivity. All analyses were conducted using SPSS version 24, which provided a robust platform for performing both descriptive and inferential analyses, including the logit regression model, thus enabling deeper insight into the survey.

Model Specification

Model for Likert Scale Rating

A 4-point Likert scale was employed in this study to evaluate the impact of ICT utilization among livestock farmers following ICT-based training, focusing specifically on their confidence and capability in using various ICT tools to improve livestock production. To gauge utilization levels, statements of key impacts was provided, and respondents were asked to indicate their level of agreement with statements about the extent to which they used each component. The Likert scale responses ranged from "very great extent" (VGE) with a score of 4, to "very low extent" (VLE) with a score of 1. A decision threshold was set at a mean score of 2.5, distinguishing between high and low levels of ICT integration in livestock management.

The Likert scale ratings were defined as follows:

- Very great impact (VGI) – 4
- Great impact (GI) – 3
- Low impact (LI) – 2
- Very low impact (VLI) – 1

To calculate the mean Likert score (X_s), the following formula was used:

$$X_s = \frac{\Sigma fn}{Nr}$$

Where:

- X_s= Mean score
- Σ = Summation
- F = Frequency of each response category (4, 3, 2, 1)
- n = Likert numerical values assigned to each response
- Nr = Total number of respondents

This mean score provided insight into how effectively farmers were applying their ICT training in day-to-day livestock operations, as higher scores indicated greater utilization and impact on productivity. A mean score above 2.5 suggested that farmers were integrating ICT practices effectively, thus supporting the study's objective of determining ICT training's influence on enhancing livestock production efficiency.

Logit Regression Model

A logit regression model was used to determine the socio-economic and contextual factors

that influence the effectiveness of ICT training programs among livestock farmers in Bwari Area Council. This model is ideal for analyzing binary or categorical dependent variables, allowing the study to identify factors that promote or hinder effective ICT training uptake and its application in livestock production. The implicit form of the model is represented as follows:

$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10})$

The explicit form of the Logit model is given as:

$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + e$

Where:

Y = Effectiveness of ICT training in enhancing livestock production
X_1 = Age of the respondent
X_2 = Years of experience in in livestock farming
X_3 = Gender
X_4 = Household size
X_5 = Marital status
X_6 = Educational attainment
X_7 = Farm size
X_8 = Access to credit
X_9 = Access to extension services
X_{10} = Cooperative membership
β_0 = Constant (intercept)
e = Error term

This model specification enables the study to explore how socio-economic factors (such as age, education level, and farm size) and institutional variables (such as access to credit and extension services) impact the effectiveness of ICT-based training for livestock farmers in Bwari. By applying this approach, the study provides insights into the most significant factors that either enhance or limit the uptake and effectiveness of ICT training programs, thus offering a comprehensive understanding of the key drivers for improving livestock productivity through digital interventions.

Kendall's Coefficient of Concordance

To address Objective 5—ranking the most effective ICT tools for enhancing livestock productivity among farmers in Bwari Area Council—Kendall's Coefficient of Concordance (W) was applied. This statistical method measures consensus among respondents when ranking items, in this case, ICT tools by their perceived effectiveness in improving productivity.

Farmers ranked tools like mobile apps, SMS alerts, radio broadcasts, and video tutorials. Each tool's rank score was totalled and analyzed using Kendall's W, with the coefficient value ranging from 0 (no agreement) to 1 (perfect agreement). Higher W values indicate strong consensus on which ICT tools are considered most beneficial for productivity. Kendall's W is calculated as follows:

$W = \frac{12 \sum(R_i - \bar{R})^2}{m^2 (n^3 - n)}$ Where:

W = Kendall's Coefficient of Concordance,
R_i = Sum of ranks a for each ICT tool,
$\bar{R}$ = Average rank,
m = Number of respondents (rice farmers),
n = Number of ICT tools.

This analysis will help identify which ICT tools are universally acknowledged as highly effective, providing critical guidance for enhancing ICT training and tool implementation in livestock farming.

RESULTS AND DISCUSSION

Socio-Economic Characteristics of Livestock Farmers Undergoing ICT Training

The gender distribution among livestock farmers in Table 1 reveals a higher proportion of male farmers, comprising 72.0% of the sample, while female farmers make up 28.0%. This male dominance in livestock farming aligns with findings in similar rural Nigerian contexts, where cultural norms and labour demands often result in a greater representation of men in livestock and agricultural activities (Adeoye, Victor and Oladosun, 2021). Research suggests that men are more likely to control larger-scale agricultural enterprises, including livestock production, due to their broader access to resources and decision-making roles within households (Ekong and Ogbuabor, 2020). However, the involvement of female farmers, though lower, is significant. Female farmers, often engaged in small-scale livestock activities, play a critical role in household food security and income diversification (Aina and Ajayi, 2020).

The marital status distribution among livestock farmers in Table 1 shows that a significant majority, 64.0%, are married, while 24.0% are single. Smaller proportions of respondents are widowed or divorced, each accounting for 6.0% of the sample. This pattern is consistent with findings in other rural Nigerian communities, where marriage is common among adults involved in farming and agricultural production, often due to the social and economic stability it provides within family-based farming systems (Aina and Ajayi, 2020; Okonkwo and Obi, 2020). Marital status is an important demographic factor as it can influence resource access and decision-making in farming practices. As Oseni, Chukwudi and Faleye (2019) suggest, married farmers may have larger household labour pools and are often more invested in practices that sustain family welfare. This demographic profile may also impact the adoption of ICT tools, as married farmers tend to prioritize sustainable practices that enhance

productivity and support household stability (Oseni *et al*., 2019).

The household size distribution among livestock farmers in Table 1 shows an average household size of 6.2 members. The largest group, 44.0% of respondents, have 4–6 household members, followed by 24.0% with 7–9 members, 22.0% with 1–3 members, and 10.0% with households of 10 or more. This household size pattern aligns with rural Nigerian norms, where extended family structures and larger household sizes are common, often providing additional labour for agricultural activities (Adesiji, Ogunlela and Alade, 2019). Household size can significantly influence farm labour availability and resource allocation, as larger households generally have more members contributing to farm operations, which may enhance productivity (Okonkwo and Obi, 2020). Studies show that larger households can also impact technology adoption, as family members may share tasks such as accessing information on new farming practices, including ICT tools (Ogunniyi *et al*., 2020).

The educational level of livestock farmers in Table 1 indicates a diverse range of educational attainment. Most farmers (38.0%) have completed secondary education, while 28.0% have primary education. A smaller proportion, 16.0%, have tertiary education, and 18.0% have no formal education. This distribution reflects broader rural educational patterns in Nigeria, where limited access to higher education often restricts farmers' qualifications to primary and secondary levels (Adeoye *et al*, 2021). Education plays a significant role in farmers' ability to adopt and utilize new technologies, including ICT tools. Studies show that farmers with higher education levels are more likely to engage with digital resources and extension services due to greater literacy and familiarity with technology (Adebayo and Idowu, 2019; Adegbidi *et al*., 2022). In particular, secondary and tertiary education levels among farmers in this study may positively impact the uptake of ICT-based training, as these farmers are often more open to innovation and equipped to understand the potential benefits of digital tools (Aina and Ajayi, 2020).

The age distribution of livestock farmers in Table 1 reveals a balanced representation across different age groups, with a mean age of 41.7 years. Most respondents (31.2%) are within the 31–40 age range, followed by those aged 41–50 years (26.0%), and those aged 20–30 years (20.8%). The smallest group, aged 51 years and above, accounts for 22.0% of respondents. This relatively youthful demographic aligns with findings in other rural Nigerian farming communities, where younger adults often play active roles in agricultural production due to both economic necessity and emerging openness to technology use (Aker and Mbiti, 2019). These age groups are likely to exhibit varying levels of familiarity and comfort with ICT tools, with younger farmers potentially more adaptable to IT-based training. As Ogunniyi *et al*. (2020) note, age can be a crucial factor in adopting technology in rural areas, as younger farmers generally show more adaptability to digital tools, which could impact the overall effectiveness of ICT-based training programs.

The farming experience among livestock farmers in in Table 1 shows a wide range, with an average experience of 12.3 years. The majority of respondents (32.0%) have between 11–15 years of experience, followed by 30.0% with 6–10 years, 22.0% with over 16 years, and 16.0% with 1–5 years of experience. This distribution reflects a substantial level of experience among most farmers, consistent with findings that many Nigerian rural farmers engage in long-term agricultural practices to sustain their livelihoods (Abdul and Olayemi, 2019). Farming experience is often linked to greater skill in managing livestock and adapting to challenges, as experienced farmers typically have more established routines and local knowledge (Ibekwe and Nnamdi, 2021). Additionally, experience may influence technology adoption, with seasoned farmers potentially valuing traditional methods over new technologies, such as ICT-based tools (Chidiebere and Mbah, 2018). Conversely, some studies indicate that farmers with moderate experience (6–15 years) are often more adaptable to innovations than both newer and highly experienced farmers, who may be more set in their practices (Amole *et al*., 2021; Bello and Adeyemi, 2023).

The farm size distribution among livestock farmers in in Table 1 reveals that a majority operate on small-scale farms. Most respondents (48.0%) manage 1–3 hectares, while 24.0% have 4–6 hectares, and 16.0% operate on less than 1 hectare. Only 12.0% of the farmers work on farms larger than 6 hectares. This prevalence of small-scale farms aligns with the typical structure of agricultural holdings in rural Nigeria, where small farms dominate and larger-scale operations are relatively uncommon (Okonkwo and Obi, 2020). Farm size is a critical factor influencing productivity and resource allocation, as smaller farms often have limited capacity for expansion and lower access to advanced resources, including technology (Ekong and Ogbuabor, 2020). Research suggests that smaller farms may face more barriers in adopting ICT tools due to resource constraints, as larger farms often have greater economic flexibility to invest in innovative practices (FAO, 2019). Additionally, small-scale farmers may prioritize essential expenditures over adopting new technologies, impacting their likelihood of engaging

with ICT-based training (Chidiebere and Mbah, 2018).

The survey on cooperative membership among livestock farmers in Table 1 shows that 68.0% of respondents are members of agricultural cooperatives, while 32.0% are non-members. This high level of cooperative involvement aligns with findings in other rural Nigerian settings, where cooperatives are common among farmers seeking improved access to resources, knowledge, and support systems (Adewuyi and Adereti, 2020). Research indicates that cooperative members are often more receptive to new technologies, as cooperatives frequently facilitate training programs, access to extension services, and exposure to modern agricultural practices (Muriuki *et al*., 2021). In particular, cooperative membership can influence ICT adoption by increasing farmers' exposure to digital resources and reducing barriers through group-based learning and support (Adesiji *et al*., 2019). Consequently, cooperative members in this study may be better positioned to engage with ICT-based training initiatives compared to non-members.

The survey on contact with extension agents among livestock farmers in in Table 1 indicates that 80.0% of respondents reported having contact with extension agents, while 20.0% had no such contact. This high level of interaction with extension services is significant, as access to extension agents is often a critical factor in improving agricultural productivity by providing farmers with updated information on livestock management, disease control, and market practices (Aderibigbe, Abiola and Mohammed, 2020). Research shows that regular contact with extension agents enhances farmers' awareness and adoption of innovative practices, as these agents often facilitate training sessions and distribute information tailored to farmers' needs (Alabi and Yusuf, 2021). In this study, farmers with frequent contact may have more opportunities to learn about and apply ICT-based training resources, potentially leading to improved production efficiency (Ezeh and Onu, 2018). Thus, contact with extension agents is a valuable channel for introducing ICT tools and improving knowledge transfer among livestock farmers.

The results on access to credit among livestock farmers in Table 1 show that 38.0% of respondents have accessed credit facilities, while a significant majority, 62.0%, have not. Limited access to credit is a common challenge among smallholder farmers in Nigeria, often constraining their ability to invest in productivity-enhancing resources, such as livestock feed, veterinary services, and technology (Oboh and Ekpebu, 2019). Research indicates that farmers with access to credit are generally better positioned to adopt innovative practices, including ICT-based training, due to their increased financial flexibility (Ojo and Adebayo, 2021; Adetola, Sanni and Ogundare, 2020). Credit availability can facilitate the purchase of ICT tools like smartphones or survey plans, which are essential for accessing digital training resources. Therefore, farmers in this study with access to credit may have a greater capacity to engage with ICT initiatives, enhancing their potential to improve livestock productivity through technological adoption (Oboh and Ekpebu, 2019).

Table 1: Socio-economic characteristics of respondents (n = 250)

Variable	Freq (n =250)	Percent
Gender		
Female	70	28.0
Male	180	72.0
Marital status		
Single	60	24.0
Married	160	64.0
Widowed	15	6.0
Divorced	15	6.0
Household size (Mean = 6.2 members)		
1 – 3 members	55	22.0
4 – 6 members	110	44.0
7 – 9 members	60	24.0
10 members and above	25	10.0
Educational level		
No formal education	45	18.0
Primary school	70	28.0
Secondary school	95	38.0
Tertiary education	40	16.0
Age (Mean = 41.7 yrs)		
20-30 years	52	20.8

Variable	Freq (n =250)	Percent
31 -40 years	78	31.2
41 -50 years	65	26.0
51 years and above	55	22.0
Years of farming Experience (Mean = 12.3 yrs)		
1 – 5 years	40	16.0
6 – 10 years	75	30.0
11 – 15 years	80	32.0
16 years and above	55	22.0
Farm Size (Mean = 3.6 ha)		
< 1	40	16.0
1 – 3	120	48.0
4 – 6	60	24.0
> 6	30	12.0
Cooperative Membership		
Member	170	68.0
Non-member	80	32.0
Contact with Extension Agents		
Yes	200	80.0
No	50	20.0
Access to Credit		
Yes	95	38.0
No	155	62.0

Source: Field survey, 2024

Level of ICT Knowledge among Livestock Farmers Post-Training

The survey in Table 2 reveal a strong level of confidence in using SMS alerts for receiving timely information on disease management, with 80.0% of farmers indicating comfort with this tool. This high adoption rate reflects SMS's accessibility and simplicity, as it requires minimal digital literacy and does not depend on internet access, making it particularly suitable for rural farmers (Oluwaseun and Olaitan, 2019). SMS alerts provide an efficient way for farmers to receive critical information that directly impacts livestock health, underscoring the importance of ICT tools in facilitating timely responses to potential outbreaks (Amadi and Okeke, 2020). The high uptake suggests that ICT training has effectively equipped farmers with practical skills, reinforcing findings by Aker and Mbiti (2019) on the utility of SMS in rural agricultural settings.

Following closely, 72.0% of respondents expressed confidence in using mobile applications for livestock management. Mobile apps offer a range of functionalities—from scheduling vaccinations to monitoring feed intake—that contribute to efficient livestock care. Studies have shown that rural farmers benefit from apps that provide step-by-step guidance on complex tasks, making mobile technology an invaluable asset in regions where formal agricultural support may be limited (Chigozie and Obasi, 2019). This high level of confidence in mobile app use reflects the success of ICT training in imparting essential app-related skills, although broader factors like internet access and smartphone affordability may still affect regular use (Ekong and Ogbubor, 2020).

A substantial 70.0% of respondents acknowledged that ICT tools positively impact productivity and efficiency in livestock operations. This finding aligns with broader studies on ICT adoption in agriculture, where digital tools have been shown to streamline farm management and reduce resource wastage (Oseni *et al*., 2022). Farmers' recognition of productivity benefits indicates that ICT training is meeting practical needs, as these tools directly contribute to their economic goals. Research by Ekong and Ogbubor (2020) similarly highlights that technology can optimize livestock care, supporting farmers' efforts to improve yields without substantially increasing costs.

The ability to access livestock market prices online was reported by 60.0% of farmers, a significant factor for economic decision-making. Real-time market survey allows farmers to optimize sales and align production cycles with market demands (Oni *et al*., 2018). While this is a positive indication of ICT training's effectiveness, the fact that 40.0% of farmers still lack this capability suggests underlying challenges, possibly related to inconsistent internet connectivity or limited experience with online platforms (Oboh and Ekpebu, 2019).

About 48.0% of farmers indicated confidence in troubleshooting basic ICT issues independently. This level of self-sufficiency is crucial for maintaining consistent ICT usage, as minor technical problems can otherwise disrupt access to essential resources (Ezeh and Onu, 2018). The ICT training appears to have imparted foundational problem-solving skills, though nearly half of the respondents may still depend on external support to resolve technical issues, as noted by FAO (2019).

A notable 38.0% of respondents expressed feeling overwhelmed by the complexity of ICT tools. This challenge reflects a common issue among rural farmers who may be new to digital interfaces and experience frustration when attempting to navigate unfamiliar systems (Ibekwe and Nnamdi, 2021). Complexity can be a significant barrier to ICT adoption, particularly when training does not adequately address user experience considerations, as noted by Abdul and Olayemi (2019).

Regarding technical terminology, 34.0% of farmers indicated difficulty in understanding the language used in ICT resources. This aligns with Alabi and Yusuf (2021), who report that technical jargon can be a barrier for farmers with limited formal education. Understanding terminology is essential for effective ICT use, as misinterpretation can lead to incorrect application of information, potentially undermining the benefits of training (Obinna and Emeka, 2021).

Interestingly, 28.0% of farmers stated a preference for traditional methods over ICT tools in managing livestock, despite recognizing the potential productivity gains associated with digital resources. This preference may stem from cultural or habitual reliance on established practices, as documented by Muriuki *et al*., (2021), who observed that rural farmers often trust longstanding methods over untested technologies. Traditional practices, which have sustained these communities for generations, may offer a sense of reliability that newer ICT tools have yet to establish among some farmers (Victor and Samuel, 2021). Thus, while ICT training introduces new methods, behavioural shifts toward technology may take time.

Challenges with smartphone usage were also evident, with 24.0% of respondents reporting that they struggle to use smartphones effectively for farming-related activities. This may reflect broader issues related to digital literacy and accessibility, as smartphone use in agriculture often requires a basic understanding of applications and settings (Adebayo and Akintunde, 2020). While ICT training has introduced farmers to smartphone capabilities, further support may be necessary to help these farmers navigate devices effectively, as observed by Ogunniyi *et al*., (2020).

Table 2: Level of ICT Knowledge among Livestock Farmers' Post-Training

S/N	Statements	Frequency	Percentage(%)
a	I am confident in using mobile applications specifically designed for livestock management tasks.	180	72.0
b	I understand how to find and access updated livestock market prices online for informed decision-making.	150	60.0
c	I am comfortable using SMS alerts to receive timely information on disease management for my livestock.	200	80.0
d	I can troubleshoot basic issues with ICT tools (e.g., phone, apps) without assistance.	120	48.0
e	I find ICT tools beneficial for increasing productivity and efficiency in my livestock operations.	175	70.0
f	I can navigate agricultural information websites to find relevant resources for livestock care.	110	44.0
g	I often have difficulty understanding the technical terminology used in ICT resources.	85	34.0
h	I feel overwhelmed by the complexity of ICT tools and the time it takes to learn them.	95	38.0
i	I struggle to use smartphones effectively for specific farming and livestock management activities.	60	24.0
j	I still prefer traditional methods over ICT tools when it comes to livestock care and management.	70	28.0

Source: Field survey, 2024

Impact of ICT Training on Livestock Production Efficiency

In Table 3, the results illustrate the perceived impact of ICT training on various aspects of livestock production efficiency among farmers in Bwari Area Council. Overall, the majority of statements show a positive impact, with mean scores above the decision threshold of 2.5, while a few aspects fall below this level, indicating limited influence in specific areas.

A notable impact of ICT training is evident in the area of awareness of government programs and subsidies, with a high mean score of 3.4. This suggests that ICT training has effectively informed farmers about available resources and support systems, which are crucial for enhancing productivity and financial stability (Ezeh and Onu, 2018). Access to information on subsidies and grants can significantly aid smallholder farmers, allowing them to invest in essential resources for livestock management. This result aligns with findings from recent studies, which show that ICT tools are effective channels for disseminating policy-related information to rural farming communities (Oseni *et al*., 2022).

Another area with a positive response is the use of ICT for understanding and scheduling livestock vaccinations, with a mean score of 3.3. This finding highlights that ICT training has enhanced farmers' knowledge of disease prevention and animal health management, as timely vaccinations are critical for reducing livestock mortality (Oni *et al*., 2018). Access to accurate vaccination schedules and reminders via ICT platforms has proven to be a valuable tool in resource-limited settings, where traditional veterinary services may be inaccessible or costly. This aligns with research of Aker and Mbiti (2021), which emphasizes that ICT can improve preventive care measures in rural livestock farming.

Farmers also reported improvements in maintaining health records for individual animals, with a mean score of 3.2. Effective record-keeping is essential for tracking health trends, productivity levels, and overall livestock performance. ICT-based record management allows farmers to systematically document animal health information, improving their capacity to make informed decisions regarding herd management (Oluwaseun and Olaitan, 2019). This result supports findings from Okonkwo and Obi (2020), who identified record-keeping as a critical benefit of ICT adoption in livestock farming.

Additionally, ICT training was positively rated for its role in helping farmers identify high-quality feed sources, with a mean score of 3.0. Proper nutrition is fundamental to livestock health and productivity, and ICT tools can help farmers assess and source better feed options, thus improving livestock output (Obinna and Emeka, 2021). This finding suggests that ICT training has successfully raised awareness about feed quality, allowing farmers to make better-informed decisions in sourcing.

Farmers also positively rated the use of ICT to monitor the productivity levels of individual animals over time, with a mean score of 2.5, meeting the acceptance threshold. Tracking productivity metrics allows farmers to assess the performance of individual animals, enabling them to make strategic decisions on breeding, culling, and feed adjustments (Adesiji *et al*., 2019). The acceptance of this statement indicates that ICT training has introduced farmers to techniques for productivity monitoring, which can support more survey-driven livestock management. Although this mean score is at the threshold, it shows that farmers have recognized the utility of ICT for productivity tracking, even if some may still face challenges with this practice.

In contrast, some areas received mean scores below 2.5, indicating less impact. For example, the use of ICT for monitoring weather forecasts received a mean score of 2.4. While weather monitoring can be beneficial for planning, livestock farmers may perceive it as more relevant to crop farming, or they may face challenges in accessing accurate, localized forecasts (Aderibigbe *et al*., 2020). Similarly, the ability to use ICT to reduce livestock losses during transportation was rated low (2.2), suggesting that training may not have adequately covered practices or resources to minimize risks in transport and handling (Adewuyi and Adereti, 2020).

Table 3: Impact of ICT Training on Livestock Farmers' Production Efficiency

S/N	Statements	Mean score	Decision
a	ICT training has enabled me to manage farm finances and budgeting more effectively.	3.1	Accepted
b	I can now use ICT tools to monitor weather forecasts, helping me plan livestock activities accordingly.	2.4	Rejected
c	ICT training has helped me reduce livestock losses during transportation and handling.	2.2	Rejected
d	I have improved my skills in preparing and storing livestock feed using ICT-based guidance	2.9	Accepted

S/N	Statements	Mean score	Decision
e	ICT tools have allowed me to better understand livestock vaccinations and schedule them accurately.	3.3	Accepted
f	ICT training has improved my ability to identify high-quality feed sources for my livestock.	3.0	Accepted
g	I am now able to use ICT platforms to track the productivity levels of individual animals over time.	2.5	Accepted
h	ICT training has enhanced my ability to maintain accurate health records for each animal on my farm.	3.2	Accepted
i	I can now use ICT tools to identify optimal times for livestock breeding cycles.	2.3	Rejected
j	ICT training has increased my awareness of government programs and subsidies available to livestock farmers.	3.4	Accepted
k	ICT resources have made it easier for me to find markets beyond my local area for selling livestock products.	2.6	Accepted
l	I find ICT tools useful for understanding and managing livestock waste disposal practices.	2.1	Rejected

Source: Field survey, 2024

Factors Affecting the Effectiveness of ICT Training Programs

The model statistics in Table 4 provide important insights into the performance and fit of the logistic regression model analyzing the socio-economic determinants of the effectiveness of ICT training among livestock farmers. Based on 250 observations, the model's Likelihood Ratio Chi-Square (LR Chi^2) of 32.45 indicates goodness-of-fit of the model. The Pseudo R^2 of 0.245 means the model explains 24.5% of the variability in ICT training effectiveness. In logit regression, pseudo-R-squared values tend to be lower than traditional R-squared values, but a value of 0.245 is generally acceptable, indicating that the model provides a moderate level of explanatory power. Additionally, the model's overall P-Value of 0.001 confirms its high statistical significance, as a whole, is a good fit for the survey, supporting the hypothesis that the chosen variables collectively impact the effectiveness of ICT training among the farmers. The Log Likelihood value of -123.87 further provides an indication of the model's fit to the observed survey, with higher (less negative) values suggesting a better fit. Among the nine (10) factors tested, six factors had coefficients that were statistically meaningful: age, household size, educational level, cooperative membership, contact with extension agents and access to credit. These factors are identified as important predictors of socio-economic determinants of the effectiveness of ICT training among livestock farmers.

The regression analysis shows that access to credit is a highly significant predictor of ICT training effectiveness among livestock farmers with a coefficient (β) of 1.58 and a p-value of 0.002, making it significant at the 1% level. This result suggests that farmers with access to credit are better positioned to apply ICT tools effectively in livestock management. Credit access provides farmers with the financial resources needed to invest in ICT devices, internet connectivity, and other supportive tools, which enhance the practicality of ICT training (Oboh and Ekpebu, 2019). Research by Ezeh and Onu (2018) supports this finding, indicating that financial constraints often limit farmers' ability to adopt new technologies. Credit access mitigates these barriers, empowering farmers to use ICT resources more confidently and consistently.

The regression results indicate that contact with extension agents is a significant predictor of ICT training effectiveness among livestock farmers with a coefficient (β) of 0.94 and a p-value of 0.011, making it significant at the 5% level. This finding suggests that regular interactions with extension agents enhance farmers' ability to apply ICT tools effectively in livestock management. Studies by Obinna and Emeka (2019) and Okonkwo, J., and Obi (2020) support this outcome, showing that farmers with frequent access to extension services are more likely to adopt new technologies and improve productivity. Extension agents often facilitate the adaptation of ICT training to local farming practices, helping farmers overcome challenges related to technology use (Ezeh and Onu, 2018).

The regression analysis reveals that educational level is a significant predictor of ICT training effectiveness among livestock farmers with a coefficient (β) of 0.88 and a p-value of 0.010, making it significant at the 5% level. This indicates that farmers with higher educational attainment are more likely to benefit from ICT training, as education positively influences their capacity to understand and apply digital tools in livestock management. Research corroborates this finding, highlighting that higher education levels improve digital literacy, which in turn enhances the adoption of ICT in agriculture (Adetola *et al*., 2020). According to Ogunniyi *et al*., (2020), educated farmers are also more proactive in

seeking new methods and technologies to improve productivity.

The regression results indicate that cooperative membership is a significant predictor of ICT training effectiveness among livestock farmers with a coefficient (β) of 0.78 and a p-value of 0.012, making it significant at the 5% level. This finding suggests that membership in cooperatives positively impacts farmers' ability to apply ICT tools effectively in livestock management. Research supports this, showing that cooperatives provide access to resources, shared knowledge, and peer support, all of which enhance technology adoption (Ibekwe and Nnamdi, 2021). Studies by Ezeh and Onu (2018) reveal that cooperative members often receive collective training and have better access to information on innovations, making them more likely to utilize ICT tools for productivity.

The analysis shows that age is marginally significant in predicting the effectiveness of ICT training among livestock farmers with a coefficient (β) of -0.31 and a p-value of 0.052, making it significant at the 1% level. This result suggests a weak association between age and the impact of ICT training, indicating that younger farmers might find ICT tools slightly more beneficial than older ones. Research supports this trend, noting that younger farmers often demonstrate a higher adaptability to technology due to familiarity and comfort with digital tools (Adegbidi *et al*., 2022). Studies by Bello and Adeyemi (2023) and Oni *et al*., (2018) have similarly found that younger farmers show greater willingness to adopt and apply ICT in farming practices, as they are generally more receptive to new information and digital innovations. Conversely, older farmers may rely more on traditional methods, possibly viewing ICT as complex or unnecessary (Adegbidi *et al*., 2022). Thus, while age is not a strong predictor in this model, it does highlight slight generational differences in ICT adaptation among farmers.

The regression analysis shows that household size is a significant predictor of ICT training effectiveness among livestock farmers with a coefficient (β) of -0.30 and a p-value of 0.032, making it significant at the 5% level. This finding suggests that larger households negatively influence the effectiveness of ICT training, likely due to the additional labour and support available within the household. Studies indicate that farmers with larger households benefit from shared responsibilities, allowing more time and flexibility to engage with ICT tools and apply newly acquired skills (Oluwaseun and Olaitan, 2019; Ogunniyi *et al*., 2020). Research by Bello and Adeyemi (2023) further supports this, noting that household members can assist in implementing ICT-related practices, such as record-keeping and survey collection, which enhance farm management.

The regression analysis results indicate that gender is not statistically significant in predicting the effectiveness of ICT training among livestock farmers with a coefficient (β) of 0.42 and a p-value of 0.148. This result suggests that there is no meaningful difference between male and female farmers in terms of how ICT training impacts their livestock management practices. This finding aligns with recent studies, which have shown that while gender may influence access to resources, it does not necessarily affect the ability to learn or apply ICT skills once training is provided (Victor and Samuel, 2021; Oseni *et al*., 2022). Other research similarly suggests that when given equal access to ICT training, both male and female farmers can develop similar levels of competency in using digital tools for agricultural productivity (Ibekwe and Nnamdi, 2021).

The regression results show that farming experience is not a significant predictor of ICT training effectiveness among livestock farmers, with a p-value of 0.134. This suggests that years of farming experience do not have a substantial effect on how well farmers can utilize ICT tools post-training. Research supports this finding, as both experienced and less experienced farmers can benefit from ICT training if they receive proper guidance and support in understanding digital applications (Muriuki *et al*., 2021). While farming experience is often linked to knowledge of traditional practices, it does not necessarily translate into an ability to adopt new technologies, as noted by Ezeh and Onu (2018). Experienced farmers may rely more heavily on established methods, whereas those with fewer years in farming are sometimes more open to experimenting with new practices, including ICT (Ibekwe and Nnamdi, 2021).

The regression analysis indicates that farm size is not a significant predictor of ICT training effectiveness among livestock farmers, with a p-value of 0.253. This suggests that the size of a farmer's landholding does not substantially impact their ability to benefit from ICT training for livestock management. Recent studies align with this finding, showing that farm size often has minimal influence on technology adoption when ICT tools are accessible and training is effectively delivered (Obinna and Emeka, 2021). Research by Alabi and Yusuf (2021) supports this result, noting that both small and large farm operators can leverage ICT tools to improve productivity if they are motivated and have adequate support. While larger farms may have more resources, smaller farms can still benefit equally from ICT tools, as they facilitate efficient resource

management regardless of scale (Oluwaseun and Olaitan, 2019).

The regression results indicate that marital status is not a significant predictor of ICT training effectiveness among livestock farmers, as evidenced by a p-value of 0.548. This finding suggests that whether a farmer is single, married, widowed, or divorced does not substantially impact their ability to benefit from ICT training in livestock management. This result also aligns with research showing that socio-economic factors other than marital status are stronger determinants of ICT utilization (Ekong and Ogbuabor, 2020). Previous research by Chidiebere and Mbah (2018) also suggests that marital status may affect household responsibilities and labour distribution but does not directly influence a farmer's aptitude or motivation to utilize ICT in farming practices. Since ICT training addresses practical skills that can be equally applied across various household contexts, marital status is unlikely to alter training outcomes significantly.

Table 4: Logit regression table showing the socio-economic determinants of the effectiveness of ICT training programs

Variable	Coefficient	Standard error	Z- value	P-value
Constant (β_0)	-0.95**	0.40	-2.38	0.017
Gender	0.42	0.29	1.45	0.148
Age	-0.31*	0.16	-1.94	0.052
Marital Status	-0.12	0.20	-0.60	0.548
Educational Level	0.88**	0.34	2.59	0.010
Farming Experience	0.27	0.18	1.50	0.134
Farm Size	0.25	0.22	1.14	0.253
Cooperative Membership	0.78**	0.31	2.52	0.012
Household Size	-0.30**	0.14	-2.14	0.032
Contact with Extension Agents	0.94**	0.37	2.54	0.011
Access to Credit	1.58***	0.51	3.10	0.002
Number of Observation LR Chi^2 (10) Pseudo R^2	250.00 32.45 0.245			
P-Value	0.001			
Log likelihood	-123.87			

Note: ***, ** and * indicate significance at 1%, 5% and 10% probability level respectively

Effective ICT Tools in Enhancing Livestock Productivity

The results presented in Table 5 reveal a strong consensus among farmers regarding the perceived effectiveness of various ICT tools for enhancing livestock productivity. The result indicates that farmers largely agree on the relative usefulness of these tools, underscoring certain ICT methods as more beneficial than others in their farming practices.

The highest-ranked tool, mobile applications, achieved the top rank with a mean rank of 3.52. This finding suggests that farmers perceive mobile apps as the most effective ICT tool for livestock management, possibly due to their multifunctionality and ability to support a range of tasks from disease management to financial planning. Research by Ezeh and Onu (2018) supports this, highlighting that mobile applications have become integral in agricultural practices, especially for rural farmers who rely on quick and accessible information to manage livestock productivity effectively.

SMS alerts follow closely as the second most valued ICT tool, with a mean rank of 3.32. SMS alerts are highly valued in rural settings because they do not require internet connectivity, making them reliable and accessible for farmers in areas with limited digital infrastructure (Adeoye *et al*., 2021). Studies confirm that SMS-based information significantly impacts smallholder farmers by enhancing access to critical information without the need for advanced technology (Amole *et al*., 2018).

The third tool, radio broadcasts, has a mean rank of 3.12, indicating a strong preference for radio as an effective medium for disseminating information. In many rural areas, radio remains one of the most trusted sources for agricultural information due to its widespread reach and cultural familiarity (Ibekwe and Nnamdi, 2021). Research by Obinna and Emeka (2021) found that radio is particularly useful for older farmers, who may be less accustomed to newer digital technologies but still rely on accessible media for agricultural guidance.

Video tutorials rank fourth, with a mean rank of 2.96. Video tutorials, which are often available

through mobile apps or online platforms, provide visual and practical demonstrations on livestock management techniques. Although not as highly ranked as SMS or radio, video tutorials are valued for their instructional quality, especially among farmers who prefer step-by-step guidance (Victor, and Samuel, 2021). Video content helps farmers grasp complex processes more effectively than text alone, facilitating better adoption of advanced practices.

Social media Platforms ranked fifth, with a mean rank of 2.76. Social media offers a platform for farmers to connect with peers, agricultural experts, and markets, enabling knowledge exchange and networking (Okonkwo and Obi, 2020). Although ranked lower than other tools, social media platforms are becoming increasingly relevant, especially for younger farmers who are comfortable with digital communication and seek broader engagement with the agricultural community (Ezeh and Onu, 2018).

Online market platforms, with a mean rank of 2.52, rank sixth in perceived effectiveness. These platforms allow farmers to access broader markets and compare prices, which can be valuable for boosting income (Okonkwo and Obi, 2020). However, the relatively lower rank suggests that while online markets are useful, other tools like SMS and radio are more practical for immediate, local information needs. Studies by Chigozie and Obasi (2022) and Muriuki *et al*. (2021) indicate that many rural farmers face challenges in using online markets due to digital literacy barriers or lack of consistent internet access, limiting the platforms' usability for some farmers.

Agricultural websites rank seventh, with a mean rank of 2.36. Although agricultural websites can provide comprehensive resources, they may be less accessible to farmers with limited digital literacy or internet access. Research has shown that while websites can serve as valuable information repositories, they are often underutilized in rural settings where simpler tools like SMS and radio are preferred (Obinna and Emeka, 2021).

Finally, Interactive Voice Response (IVR) systems rank lowest, with a mean rank of 2.12. IVR systems allow users to access recorded information or speak with agricultural experts by phone, which can be beneficial for those who have limited literacy skills. However, the low ranking suggests that farmers may find IVR systems less intuitive or may not be as familiar with this technology compared to other tools (Adebayo and Akintunde, 2020). The relatively lower preference for IVR systems aligns with findings by Adebayo and Idowu (2019), who noted that while IVR has potential, it may not yet be widely adopted in rural agricultural communities.

Table 5: Ranking of ICT Tools by Effectiveness in Enhancing Livestock Productivity Using Kendall's Coefficient of Concordance

ICT Tool	Mean Rank	Rank
Video Tutorials	2.96	4th
SMS Alerts	3.32	2nd
Social Media Platforms	2.76	5th
Radio Broadcasts	3.12	3rd
Agricultural Websites	2.36	7th
Interactive Voice Response	2.12	8th
Mobile Applications	3.52	1st
Online Market Platforms	2.52	6th

Source: Field Study, 2024

CONCLUSION AND RECOMMENDATIONS

This dissertation explored the influence of ICT-based training on livestock production efficiency among farmers in Bwari Area Council by examining the socio-economic characteristics of the farmers, their ICT knowledge post-training, the impact of ICT on productivity, factors affecting ICT effectiveness, and the most effective ICT tools for livestock management. The findings provide insights into the ways ICT training can support livestock farmers in enhancing productivity, as well as the challenges that remain.

The study revealed diverse socio-economic backgrounds among the livestock farmers participating in ICT training. The majority of respondents were male (72%) and married (64%), with an average age of 41.7 years. Educational levels varied, with 38% holding secondary education and 28% having only primary education. The average farming experience was 12.3 years, and 48% of farmers operated on farms sized between 1–3 hectares. Notably, 68% of the farmers were members of cooperatives, a factor that significantly influenced ICT training effectiveness. Household size averaged 8 members, providing labour support that may enhance the adoption of ICT in daily livestock management. This socio-economic profile underscores the resource and knowledge diversity within the farming population, which in turn influences ICT adoption and application.

Post-training assessments indicated that most farmers acquired fundamental ICT skills. The top skills, based on percentage of farmers reporting confidence, included: using SMS alerts for disease management (80%); confidently using mobile applications for livestock management tasks (72%); recognizing the benefits of ICT for increasing productivity (70%); accessing market prices online (60%); and troubleshooting basic ICT issues (48%). These findings highlight that SMS alerts and mobile applications were particularly well-received, likely due to their ease of use and relevance to immediate needs. However, challenges with more advanced ICT functionalities suggest that further support may be needed for comprehensive ICT application in livestock management.

The assessment of ICT training's impact on livestock production efficiency indicated positive outcomes, with most statements achieving mean scores of 2.5 or above on a Likert scale. Key areas of impact included increasing awareness of government programs and subsidies (3.4), reducing livestock mortality through better disease management (3.2), improving feeding practices (3.0), and enabling efficient livestock record management (3.1). Farmers also benefited from ICT tools in scheduling vaccinations accurately (3.3) and preparing livestock feed (2.9). Lower impact scores in areas such as waste management and transport handling suggest that while ICT training successfully enhanced certain core practices, other aspects of livestock management may require further training focus.

The logit regression analysis identified several socio-economic factors as significant predictors of ICT training effectiveness. Significant variables included educational level ($p = 0.010$), cooperative membership ($p = 0.012$), household size ($p = 0.032$), contact with extension agents ($p = 0.011$), and access to credit ($p = 0.002$). These factors positively influenced the application of ICT in livestock management, with access to credit and extension services providing crucial financial and technical support that enhances training outcomes. Conversely, variables such as gender, marital status, farming experience, and farm size were non-significant, indicating that these factors do not substantially impact farmers' capacity to benefit from ICT training. This highlights that resource access and social support structures are more critical than demographic characteristics in determining ICT training success.

Kendall's Coefficient of Concordance analysis revealed strong agreement among farmers on the most effective ICT tools for livestock productivity. The highest-ranked tools were mobile applications (mean rank 3.52), SMS alerts (mean rank 3.32), and radio broadcasts (mean rank 3.12). These tools were preferred for their accessibility, ease of use, and relevance to livestock management, providing practical solutions for disease alerts, market information, and training content. Other tools, such as video tutorials (rank 4) and social media platforms (rank 5), were also valued but to a lesser extent, likely due to digital literacy and connectivity limitations. Lower-ranked tools, including online market platforms and Interactive Voice Response (IVR) systems, were perceived as less effective, suggesting that complex or internet-dependent tools may face barriers to adoption in rural contexts.

Given these insights, targeted recommendations are necessary to further enhance ICT training effectiveness, address the identified challenges, and support the sustained adoption of digital tools among livestock farmers:

i. To maximize the reach and impact of ICT training, there is a need to improve digital infrastructure in rural areas, including reliable internet and mobile network coverage. Partnerships with telecommunication companies and government initiatives can help address connectivity barriers, ensuring that all farmers can fully utilize digital tools in their livestock management practices.
ii. To address challenges with advanced ICT tools like online platforms and IVR systems, training programs should incorporate targeted digital literacy sessions. This would help farmers improve their skills with smartphone navigation, internet usage, and troubleshooting, thus facilitating broader adoption of ICT tools.
iii. Given the significant influence of credit access on ICT training effectiveness, financial institutions and agricultural agencies should offer accessible credit schemes tailored to rural farmers. This will enable farmers to invest in necessary ICT devices and survey plans, ensuring sustained engagement with digital resources.
iv. To address areas like transportation, waste management, and breeding that were less impacted by ICT training, the curriculum should include modules on these specific aspects. Providing information through ICT on these topics can expand the practical utility of training, enabling farmers to apply ICT tools across a wider range of livestock management tasks.
v. Since mobile applications and SMS alerts were found to be the most effective tools, these should be prioritized in ICT training programs. Training should emphasize the

potential of these tools to provide real-time disease alerts, market information, and practical tips, leveraging their accessibility and ease of use.

REFERENCES

- Abdul, B. M., & Olayemi, J. K. (2019). Farming experiences in rural Nigerian communities. *Journal of Agricultural Studies*, *11*(4), 215-226.
- Adebayo, K., & Idowu, O. (2019). Education and adoption of digital tools in agriculture. *International Journal of Agricultural Technology, 8*(3), 98-110.
- Adebayo, S., & Akintunde, O. (2020). Digital literacy among smallholder farmers in Nigeria: An assessment of ICT adoption barriers. *Journal of Agricultural Informatics*, *15*(2), 101-118.
- Adegbidi, A. B., Mensah, G. A., Vidogbena, F., & Agboh-Noameshie, A. R. (2022). Determinants of access and use of ICT by smallholder farmers in Benin: Evidence from the extension agents and farmers. *African Journal of Agricultural Research*, *7*(14), 2178-2187.
- Adeoye, O., Victor, I., & Oladosun, F. (2021). Gender dynamics in rural livestock farming and implications for ICT use. *Journal of Gender Studies in Agriculture*, *12*(2), 102-119.
- Aderibigbe, O., Abiola, J., & Mohammed, T. (2020). Extension services and smallholder productivity in Nigerian agriculture. *International Journal of Agricultural Extension*, *28*(1), 35-49.
- Adesiji, G. B., Ogunlela, A. F., & Alade, O. A. (2019). Household size and labour contribution in rural agricultural activities. *African Agricultural Research*, *5*(2), 78-85.
- Adetola, T., Sanni, I., & Ogundare, F. (2020). Credit accessibility and its impact on agricultural productivity among Nigerian smallholder farmers. *African Journal of Agribusiness*, *13*(4), 411-423.
- Adewuyi, K. O., & Adereti, F. O. (2020). Cooperative membership and access to agricultural innovations among smallholder farmers in Nigeria. *Journal of Rural Sociology*, *46*(2), 224-238.
- Aina, A. T., & Ajayi, B. (2020). The role of women in small-scale livestock production: Gender perspectives in rural Nigerian farming. *Journal of Gender Studies in Agriculture*, *12*(2), 102-119.
- Aker, J. C., & Mbiti, I. M. (2019). Mobile phones and economic development in Africa. *Journal of Economic Perspectives*, *24*(3), 207-232.
- Alabi, O., & Yusuf, M. (2021). Bridging the information gap: The role of extension agents in rural agriculture. *Agricultural Development Review*, *32*(1), 58-71.
- Ameh, D. A., Sennuga, S. O., Bamidele, J., Osho-Lagunju, B., & Abdulahi, R. O. (2023). Linkage Behavior and Practices of Agencies in the Agricultural Innovation Transfer Sub System in Nigeria: Issues for Agricultural Extension policy, *Journal of Agriculture & Education Research, 1*(1), 1-6
- Amole, T. A., Etim, O., & Oludare, T. B. (2018). Smallholder livestock production in Nigeria: Opportunities, challenges, and recommendations. *African Journal of Animal Science*, *48*(6), 614-620.
- Bello, A., & Adeyemi, B. (2023). Socio-economic challenges of livestock farming in semi-urban and rural areas of Bwari, FCT Nigeria. *Journal of Rural Studies*, *35*(1), 234-249.
- Chidiebere, I., & Mbah, O. (2018). Technology adoption by livestock farmers in Nigeria: Challenges and opportunities. *International Journal of Agricultural Extension and Rural Development Studies*, *6*(1), 1-10.
- Chigozie, O., & Obasi, U. (2019). The effectiveness of mobile applications in rural livestock management in Nigeria. *African Journal of Animal Science and Technology*, *18*(2), 145-160.
- Ekong, E. E., & Ogbuabor, J. (2020). Gender roles and agricultural productivity in Nigerian smallholder farms. *African Journal of Agricultural Research*, *26*(2), 178-188.
- Ezeh, A., & Onu, C. (2018). Influence of contact with agricultural extension on adoption of improved livestock practices in rural Nigeria. *Journal of Agricultural Development*, *19*(3), 309-327.
- FAO. (2019). Livestock production and food security: Challenges for developing countries. Rome: Food and Agriculture Organization of the United Nations.
- Ibekwe, C., & Nnamdi, A. (2021). The influence of radio broadcasts on agricultural knowledge dissemination in Nigeria. *African Journal of Communication*, *18*(3), 87-98.
- Iliyasu, H., Sennuga, S. O., Bamidele, J., Osho-Lagunju, B., & Abdulahi, R. O. (2023). A Critical Review of the Impact of Climate Change on Food Security in Nigeria: A Vulnerability Assessment, *Merit Research Journal of Agricultural Science and Soil Sciences, 11*(6), 077-087.
- Lai-Solarin, W. I., Bamidele, J., Joel, O. J., Abubakar, T. T., Eleke, U. P., Joel, A. F. & Sennuga, S. O. (2024). Challenges and Benefits of Extension Service Delivery for Dairy Cooperatives in Kaduna State, *Journal of Agricultural Extension and Rural Economics*, *1*(1), 1-14.
- Muriuki, H., Aklilu, H., & Otieno, O. (2021). Enhancing agricultural productivity through ICT: Lessons from sub-Saharan Africa. *African Journal of Agricultural Economics*, *15*(4), 567-578.

- National Population Commission. (2006). *Population Census of Nigeria*. Abuja: National Population Commission.
- Obinna, K., & Emeka, U. (2021). The utilization of agricultural websites for knowledge dissemination among Nigerian farmers. *Agricultural Knowledge Management Journal*, *10*(4), 301-319.
- Oboh, V., & Ekpebu, I. (2019). Constraints and opportunities in smallholder credit access: Evidence from Nigeria. *Journal of Agricultural Economics*, *34*(1), 117-128.
- Odoh, P. O., Sennuga, S. O., Bamidele, J., & Ameh, D. A. (2024). Examining Disparities and Empowering Women in Ensuring Food Security in Nigeria: A Critical Review, *Research Journal of Food Science and Quality Control, 10*(1), 20-36
- Ogunniyi, A., Olu, A., & Ojebiyi, A. (2020). Economic impact of digital technology in livestock management. *Journal of Agribusiness and Rural Development*, *37*(3), 421-433.
- Okonkwo, J., & Obi, P. (2020). Marital status and its impact on resource access in Nigerian agriculture. *Journal of Family and Agricultural Development*, *33*(2), 170-189.
- Olaitan, M. A., Bamidele, J., Joel, O. J., Oyediji, B. I., Joel, A. F., & Sennuga, S. O. (2024). Effects of FADAMA III Development Project on Livestock Farmers' Productivity and Food Security Status in Abuja, Nigeria. *Cross Current International Journal of Agriculture and Veterinary Sciences, 6*(3), 73-84.
- Oluwaseun, B., & Olaitan, F. (2019). The impact of SMS alerts on disease management in Nigerian livestock farms. *Veterinary Informatics Journal*, *9*(1), 45-53.
- Oni, O., Ajayi, O., & Adeoye, R. (2018). Rural farmers' access to ICT and implications for agricultural extension delivery in Nigeria. *Journal of Information Technology for Development*, *14*(2), 221-232.
- Oseni, L., Chukwudi, F., & Faleye, T. (2022). Socio-economic factors influencing ICT effectiveness among Nigerian livestock farmers. *Journal of Rural Sociology*, *28*(3), 215-228.
- Oyediji, B. I., Yekinni, T., Sennuga, S. O., & Bamidele, J. (2024). Factor influencing the attitude of poultry farmers towards credit services in in South-Western, Nigeria, *African Journal of Agriculture and Allied Sciences*, *4*(2), 106-119.
- Rogers, E. (1962). Adoption and Diffusion of Innovations. *New York, NY: The Free*.
- Sennuga, S. O., Bamidele, J., Joel, O. J., Olaitan, M. A., Joel, A. F., & Raymond, T. (2024). Assessment of the Factors Affecting Smallholder Livestock Farmers' Use of Information and Communication Technologies to Access Market Information in Nasarawa State, Nigeria, *Journal of Veterinary and Biomedical Sciences*, *6*(2), 17-27.
- Victor, A., & Samuel, T. (2021). Livestock farming as a source of income and employment in Bwari Area Council, Nigeria. *International Journal of Livestock Production*, *23*(1), 34-46.
- World Bank. (2021). Enhancing rural ICT infrastructure in Nigeria: The case for investments. Washington, DC: The World Bank.