

**AVAILABILITY AND UTILIZATION OF DIGITAL TOOLS
AMONG CATFISH FARMERS IN IKA NORTH EAST LOCAL
GOVERNMENT AREA OF DELTA STATE**

BY

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UNIVERSITY OF BENIN
BENIN CITY**

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**A PROJECT SUBMITTED TO THE DEPARTMENT OF AGRICULTURAL
ECONOMICS AND EXTENSION SERVICES, FACULTY OF
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CERTIFICATION

This is to certify that the research work on the Availability and Utilization of Digital Tools Among Catfish Farmers in Ika North East Local Government Area of Delta State was carried out by **Favour OKOH** with the Mat. No **AGR2000034** under the supervision of the Department of Agricultural Economics and Extension Services, Faculty of Agriculture, University of Benin, Edo State, Nigeria.

Dr. (Mrs.) A. I. Kenneth
(Project Supervisor)

Date

Dr. J. I. Osabuohien
(Ag. Head of Department)

Date

DEDICATION

With a heart full of gratitude, I dedicate this work to Almighty God, whose boundless love, wisdom, and grace have guided me through every moment of this journey. His strength has carried me, His light has directed me, and His blessings have made this achievement possible.

I also lovingly dedicate this project to my dear parents, whose sacrifices, prayers, and unconditional support have been my greatest source of courage. Your love has nurtured my dreams, your encouragement has sustained my spirit, and your belief in me has inspired me to strive beyond my limits. I am forever grateful for everything you do.

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ABSTRACT

This study examined the availability and utilization of digital tools among catfish farmers in Ika North East Local Government Area of Delta State. The specific objectives were to describe the socio-economic characteristics of the farmers, identify available digital tools, assess farmers' awareness and utilization levels, and identify the constraints affecting digital tool usage. A multistage sampling technique was employed to select 120 catfish farmers, and data were collected using a structured questionnaire and interview schedule. Descriptive statistics such as frequencies, percentages, means, and standard deviations were used to analyze the objectives, while multiple regression analysis was employed to test the hypothesis. Findings revealed that catfish farming in the area is dominated by middle-aged farmers, with an average age of 42 years and 71.7% being male. The farmers were also well educated, as 57.5% had tertiary education, while 26.7% had secondary education. In addition, the respondents had 9 years of farming experience. Regarding the digital tools, mobile phones (98.3%), WhatsApp (85.8%), Facebook (83.3%), mobile banking (72.5%), and YouTube (69.2%) were the most readily available and widely known digital tools among the farmers. Awareness of digital tools was generally high across platform ranging from 98.3% for mobile phones to 16.7% for Pay-Per-Click (PPC) services of these tools was high for mobile phone, Whatsapp, Facebook, Mobile banking and YouTube. Utilization was greatest for basic tools such as mobile phones (4.60). Farmers reported several constraints affecting digital tool use. The most pressing challenges included inadequate operating capital, high cost of ICT devices, unstable power supply, high internet subscription costs, and limited digital literacy, all highlighted in the reported mean scores in the constraints section of the study.

The regression model revealed that socio-economic characteristics significantly influenced digital tool utilization among the farmers, with the model producing 0.001, indicating a strong overall relationship. Among the predictors, education level (0.004), years of farming experience (0.027), annual income (0.021), and association membership (0.015) emerged as statistically significant determinants of utilization. Hence, the study concluded that although catfish farmers have high awareness of digital tools, utilization remains centered on simple and readily accessible technologies. Addressing financial, infrastructural, and capacity-related constraints will be essential to enhancing digital adoption in aquaculture. The findings from the study recommends that the government agencies, NGO's, and extension services should improve digital literacy training, better access to affordable devices and credit, enhanced internet connectivity, and strengthened cooperative support systems to optimize digital tool utilization and boost aquaculture productivity in the study area.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the study

Aquaculture has emerged as one of the fastest-growing agricultural subsectors globally, contributing significantly to food security, employment creation, and income generation. As the global demand for animal protein continues to rise, aquaculture has become a critical pillar in bridging the widening gap between fish supply and consumption (FAO, 2022). The increasing adoption of digital technologies in agricultural systems has further transformed the sector by enabling faster access to information, improving farm management efficiency, and enhancing market connectivity across different value chains. In recent years, digital tools such as mobile phones, social media platforms, mobile applications, online extension services, and e-marketing platforms have been recognized as essential innovations that support modern aquaculture practices by simplifying communication, reducing transaction costs, and improving decision-making processes (Ragasa *et al.*, 2022; Chowdhury, 2025).

Nigeria remains one of the largest aquaculture producers in Africa, with catfish farming dominating the country's freshwater aquaculture production (Okonkwo *et al.*, 2021). Catfish farming plays an integral role in supporting rural livelihoods, contributing to household income, job creation, and nutritional security, particularly in Southern Nigeria where ecological conditions favour pond aquaculture (Akinyemi

& Adewale, 2017; Adeogun *et al.*, 2020). Despite the socio-economic relevance of catfish farming, the sector still faces major productivity challenges, many of which stem from limited access to timely information on feeding practices, water quality management, disease control, and market prices (Onuorah *et al.*, 2025). Digital tools present an opportunity to address these information gaps by providing farmers with real-time advisory services, online training, virtual extension support, and enhanced market linkages (Aheto *et al.*, 2019; Sherpaw *et al.*, 2022).

Recent studies in Nigeria indicate an increasing awareness and adoption of digital technologies among aquaculture farmers, but the level of utilization varies significantly across regions. For instance, Nwoye *et al.* (2022) reported that while social media platforms, YouTube tutorials, and mobile phones are commonly used among catfish farmers and marketers, the adoption of more advanced digital tools such as agricultural mobile apps, online fish marketing platforms, and decision-support systems remains low. Similarly, Oke *et al.* (2022) found that although digital tools can enhance profitability and efficiency in fish farming, barriers such as low digital literacy, unstable internet connectivity, high cost of devices, and irregular power supply continue to limit their effective use. These challenges are more pronounced in rural and peri-urban farming communities where infrastructural deficits remain prevalent.

Within Delta State, aquaculture is a major economic activity due to the region's abundant inland water resources and favourable climatic conditions. The Delta North

Agricultural Zone, which includes Ika North East Local Government Area, hosts numerous small- and medium-scale catfish farmers who rely heavily on traditional farming practices. Although emerging research shows that farmers in the region are gradually adopting digital communication tools such as WhatsApp, Facebook, and SMS for farm management and marketing (Onuorah *et al.*, 2025), there is still limited empirical evidence on the extent of digital tool availability, awareness, and utilization among catfish farmers specifically in Ika North East. Moreover, the socio-economic characteristics of farmers such as education level, income, experience, and cooperative membership may significantly influence their ability to access and use digital tools effectively (Chowdhury, 2025; Rowan *et al.*, 2023).

Despite the growing recognition of digital technologies as catalysts for agricultural transformation, many fish farmers in Ika North East Local Government Area continue to face technological and infrastructural constraints, which may hinder their ability to leverage digital innovations for improved productivity and profitability. The limited documentation of digital tool usage patterns in this region represents a critical knowledge gap that must be addressed to inform policy interventions, extension programmes, and capacity-building initiatives. Therefore, this study seeks to investigate the availability and utilization of digital tools among catfish farmers in Ika North East Local Government Area of Delta State, with a view to understanding the socio-economic factors that shape digital adoption and identifying the constraints that limit effective utilization.

1.2 Problem Statement

Despite the growing importance of aquaculture in Nigeria and the rapid expansion of catfish farming as a major livelihood activity, the full potential of digital tools in supporting aquaculture productivity and marketing remains largely underutilized. catfish farmers require timely, accurate, and accessible information to improve production efficiency, reduce losses, access reliable markets, and enhance profitability. However, while digital technologies such as mobile phones, social media platforms, websites, mobile applications, and digital extension tools have become increasingly essential in modern agriculture, evidence suggests that their adoption among catfish farmers is uneven and constrained by multiple challenges.

Findings from Nwoye *et al.* (2022) show that although various digital tools particularly social media, YouTube, websites, and mobile applications are available to catfish marketers, utilization is often limited by high costs of devices, inadequate operating capital, poor power supply, low digital literacy, limited internet access, and insufficient awareness of available technologies. These barriers reduce farmers' ability to leverage digital tools for marketing, information sourcing, and business expansion. Similarly, the study by Onuorah *et al.* (2025) in the Delta North Agricultural Zone reveals that catfish farmers are increasingly adopting platforms such as WhatsApp, Facebook, and SMS for communication, marketing, and technical support. However, their use of more advanced digital tools remains

minimal due to unstable internet connectivity, erratic electricity supply, lack of training, and limited exposure to digital innovations.

Although Delta State, and particularly Ika North East Local Government Area, hosts a vibrant population of small- and medium-scale catfish farmers, there is currently no empirical evidence on the extent to which these farmers have access to digital tools, their level of utilization, or the specific constraints they face in adopting such technologies. The absence of localized data limits the ability of extension systems, policymakers, and development agencies to design targeted interventions that can strengthen digital readiness among farmers and improve aquaculture productivity in the region.

Given these gaps, it becomes necessary to investigate the availability and utilization of digital tools among catfish farmers in Ika North East Local Government Area, with a view to understanding existing adoption patterns, identifying key constraints, and generating evidence-based strategies to enhance digital inclusion and improve farmers' livelihoods. In view of the above, this study intends to provide an answer to the following research questions:

1.3 Research Questions

- i. What are the socio-economic characteristics of catfish farmers in Ika North East Local Government Area of Delta State?
- ii. What types of digital tools are available to catfish farmers in Ika North East Local Government Area?

- iii. What is the level of awareness of available digital tools among catfish farmers in Ika North East Local Government Area?
- iv. What is the level of utilization of digital tools by catfish farmers in Ika North East Local Government Area?
- v. What constraints affect the availability and utilization of digital tools among catfish farmers in Ika North East Local Government Area?

1.4 Objective of the study

The main objective of the study is to assess the availability and utilization of digital tools among catfish farmers in Ika North East Local Government Area of Delta State while the specific objectives are to:

- i. describe the socio-economic characteristics of catfish farmers in Ika North East Local Government Area of Delta State;
- ii. identify the types of digital tools available to catfish farmers in the study area;
- iii. assess the level of awareness of available digital tools among catfish farmers in Ika North East Local Government Area
- iv. examine the level of utilization of digital tools by catfish farmers in the study area; and to
- v. identify the constraints affecting the availability and utilization of digital tools among catfish farmers in Ika North East Local Government Area.

1.5 Justification of the study

The integration of digital tools, such as mobile phones, social media platforms, specialized mobile applications, and online information systems, has significantly transformed agricultural and aquacultural value chains globally. In Nigeria, these technologies have been shown to improve farmers' access to markets, technical information, financial services, and real-time farm management support, thereby enhancing productivity, profitability, and overall resilience within the sector (Mukail, 2024; Ifeanyi *et al.*, 2022). Empirical evidence from Uwana and Obaseki (2024) revealed that catfish farmers in Benin City actively utilize mobile phones for various business-related purposes, including communication via SMS, WhatsApp, and direct engagement with buyers.

Furthermore, several studies have investigated the role of digital technologies in aquaculture and fish marketing across Nigeria. For instance, Ifeanyi *et al.* (2022) explored the availability and utilization of digital tools among catfish marketers in the Omambala region of Anambra State. Similarly, Ofuoku *et al.* (2015) examined information media usage patterns among fish farmers in Delta State, while Oke *et al.* (2022) assessed how information and communication technology (ICT) utilization influences the profitability of catfish farming in Ogun State. Despite these valuable contributions to knowledge, there remains a noticeable empirical gap in understanding the level of utilization of digital tools among catfish farmers in Ika North East Local Government Area of Delta State, Nigeria. Specifically, limited

research exists on the extent to which these farmers utilize digital tools, the relevance of such tools to their farming enterprises, and the socio-economic or infrastructural barriers they encounter.

1.6 Hypothesis

H₀₁: There is no significant relationship between the socio-economic characteristics of the catfish farmers and their level of utilization of the digital tools in Ika North East Local Government Area of Delta State.

CHAPTER TWO

2.0

LITERATURE REVIEW

2.1 Theoretical Framework

This study is anchored on the Diffusion of Innovations (DOI) Theory developed by Rogers (2003), which explains how new technologies, ideas, or practices spread within a social system over time through communication and interpersonal interactions. The theory is relevant to understanding how digital tools are adopted and used by catfish farmers in Ika North East Local Government Area of Delta State, Nigeria.

According to DOI, adoption of innovations is shaped by five key attributes of the technology: relative advantage, compatibility, complexity, trialability, and observability. Relative advantage refers to the degree to which farmers perceive digital tools as offering superior benefits compared to traditional practices. For instance, digital advisory platforms, e-wallet systems, and water quality monitoring apps may be adopted when farmers see improvements in yield, profitability, or reduced production costs (Liakos *et al.*, 2018). Compatibility emphasizes the alignment of these tools with existing cultural norms, farming practices, and socio-economic realities of the farmers. Studies in Nigeria have shown that adoption rates increase when digital solutions are tailored to farmers' needs and local contexts (Udoh & Essien, 2020).

The complexity of a tool, or the perceived difficulty in its use, is another critical factor. Farmers are more inclined to adopt user-friendly technologies, whereas tools that require advanced digital literacy or costly technical inputs are often resisted (Akinyemi & Adewale, 2017). Trialability, which refers to the extent farmers can test an innovation on a small scale before full adoption, also plays a vital role. Pilot demonstrations and extension-led trials have been found to encourage farmers to experiment with digital tools and eventually embrace them (Eze & Nwachukwu, 2021). Observability relates to the visibility of tangible outcomes. When farmers observe early adopters benefiting from improved production efficiency or better market access, they are more likely to imitate and adopt such tools (Ekpe *et al.*, 2022).

DOI further categorizes farmers into adopter groups innovators, early adopters, early majority, late majority, and laggards. In the study area, innovators and early adopters are often commercial or well-connected farmers with greater access to financial resources, education, and digital infrastructure. By contrast, smallholders with limited resources and low literacy levels tend to belong to the late majority or laggards (Shen *et al.*, 2020). This categorization is useful in identifying the social diffusion patterns of digital tools in the aquaculture sector.

The application of the Diffusion of Innovations (DOI) theory in this study provides a systematic lens through which the adoption of digital tools among catfish farmers in Ika North East Local Government Area can be examined. Specifically, the

framework highlights how socio-economic characteristics of farmers such as age, education, farm size, and access to credit interact with technological attributes to determine adoption behavior. For instance, farmers with higher levels of education and income are more likely to perceive digital tools as advantageous, compatible with their production systems, and less complex to use compared to smallholder farmers with limited resources (Udoh & Essien, 2020).

Equally important is the role of extension services, which act as a bridge between innovation developers and end-users. Extension agents provide demonstrations, training, and technical support that reduce the perceived complexity of digital tools while enhancing their trialability and observability. By guiding farmers in practical application and interpreting outputs from digital platforms, extension workers contribute significantly to building farmers' confidence in new technologies (Eze & Nwachukwu, 2021).

Furthermore, community networks play a critical role in shaping adoption patterns. Within rural farming systems, decisions are rarely made in isolation; rather, farmers rely on peer influence, opinion leaders, and cooperative societies to evaluate the benefits of adopting innovations. When early adopters in the community successfully demonstrate improved yields, reduced risks, or better market access through digital tools, others are more likely to follow suit (Ekpe, Etim, & Akpan, 2022).

By integrating these dimensions, the DOI framework emphasizes that successful diffusion of digital tools in aquaculture cannot be achieved by focusing solely on the

technical efficiency of the tools themselves. Adoption must align with the socio-cultural realities of farmers, be supported through consistent extension outreach, and be reinforced by trust within farming communities. Thus, the framework not only explains adoption dynamics but also provides practical insights for designing interventions that promote equitable and sustainable digital transformation in the aquaculture sector.

2.2 Conceptual Framework

This study adopts Diffusion of Innovations (DOI) as the principal theoretical lens to explain how and why catfish farmers in Ika North East Local Government Area adopt and use digital tools (e.g., mobile advisory apps, water-quality loggers, feed calculators, market platforms). DOI frames diffusion as a social process in which an innovation's spread is shaped by characteristics of the innovation itself, the communication channels used, the time dimension of adoption, and the social system into which the innovation is introduced. The five innovation attributes identified by Rogers, relative advantage, compatibility, complexity, trialability, and observability, are therefore taken as core determinants of farmers' adoption decisions (Rogers, 2003).

Relative advantage is central: farmers evaluate digital tools by whether they offer clear improvements over existing practices (e.g., better feed management, earlier disease detection, faster market information). Reviews on digital farming show that perceived performance gains strongly influence the adoption of precision and data-

driven tools across agricultural contexts. Where digital tools demonstrably reduce costs or increase yields, uptake accelerates (Liakos *et al.*, 2018; Wolfert *et al.*, 2017). Compatibility and complexity determine whether tools fit local farming routines and whether farmers can use them without prohibitive effort. Studies from smallholder contexts show that tools aligned with local practices, language and schedules are adopted more readily, while high complexity and required digital literacy act as barriers (Montes de Oca Munguia *et al.*, 2021; Klerkx *et al.*, 2019).

Trialability and observability matter in tightly knit rural communities: demonstration plots, pilot projects, and visible successes by early adopters create social proof that reduces perceived risk and accelerates diffusion. Empirical work in agriculture indicates that demonstration and extension-led piloting substantially increase farmers' willingness to try digital tools (Aker *et al.*, 2016; Montes de Oca Munguia *et al.*, 2021).

DOI also helps explain adopter heterogeneity in the study area. Farmers with larger operations, higher education, greater capital, or better network access tend to be innovators or early adopters; smallholders with limited assets cluster as late adopters or laggards. This socio-economic stratification shapes diffusion paths and suggests the need for targeted interventions to bridge gaps. Empirical syntheses of agricultural adoption corroborate that farm size, education and connectivity systematically predict early adoption (Feder *et al.*, 1985; Marra *et al.*, 2003).

While DOI provides the diffusion scaffold, integrating complementary constructs strengthens the explanatory power. Task–Technology Fit (TTF) theory explains that tools are not adopted only because they are perceived as useful adoption and performance improve when tool functionality matches farmers’ task requirements (e.g., water-quality monitoring that fits routine pond management). TTF research in agricultural and information systems contexts suggests that a high fit amplifies the effect of adoption on actual performance outcomes (Elçi *et al.*, 2021).

Extension systems and research–extension–farmer linkages are critical channels mediating diffusion. Extension actors increase trialability and reduce complexity by training, demonstrations, and troubleshooting; stronger research-extension linkages and co-design with farmers improve relevance and uptake of digital tools. Recent work promoting research-extension-farmer-input linkages highlights how coordinated support and local capacity building accelerate diffusion and sustain use (Mapiye *et al.*, 2024).

In aquaculture and fisheries, recent reviews and field studies show the growing availability of smartphone apps and digital services for fish health monitoring, data collection, supply-chain coordination and market access; however, adoption depends on design fit, local language and content, connectivity, and perceived trustworthiness of providers (Rowan *et al.*, 2023; Chowdhury, 2025). These sectoral insights underscore the importance of tailoring digital tools to aquaculture tasks and local institutional contexts.

Concept of Digital Tools

Digital tools encompass a wide array of information and communication technology (ICT)-based applications, platforms, and devices designed to support decision-making, improve productivity, and enhance operational efficiency within agricultural and aquaculture systems. These tools span from basic mobile advisory services such as SMS alerts providing timely information on weather patterns, market prices, and best management practices to sophisticated innovations including water-quality loggers, automated feeders, precision sensors, and mobile applications for disease surveillance and market linkage. In aquaculture specifically, digital tools play a pivotal role in transforming traditional farming practices by enabling continuous, real-time monitoring of critical pond parameters such as pH, dissolved oxygen, temperature, and nutrient levels. This data-driven insight allows farmers to optimize feed management, track growth rates, record production metrics, and respond promptly to environmental or biological stressors, thereby enhancing productivity and reducing losses (Wolfert *et al.*, 2017; Rowan *et al.*, 2023).

The adoption of digital tools reflects the broader paradigm of “digital agriculture,” which integrates advanced technological solutions into conventional farming practices to promote sustainability, mitigate risks, and improve overall profitability. Beyond technological capabilities, the effectiveness of these tools depends heavily on their alignment with local farming conditions, including cultural practices, resource availability, and infrastructural realities. Factors such as affordability, user-

friendliness, accessibility, and the credibility of service providers critically influence the extent to which farmers adopt and benefit from these innovations (Chowdhury, 2025; Klerkx *et al.*, 2019). Consequently, the successful deployment of digital tools requires not only robust technology but also context-specific strategies that address local needs, knowledge gaps, and institutional support structures, ensuring that smallholder and commercial farmers alike can harness the full potential of ICT-driven solutions.

2.2.1 Adoption of Digital Tool Usage

The adoption of digital tools by farmers refers to the process through which agricultural producers integrate information and communication technology (ICT)-based innovations into their farming practices to improve decision-making, enhance productivity, and optimize resource management. This adoption is influenced by a combination of technological, socio-economic, and institutional factors that determine the extent to which farmers are willing and able to use digital solutions effectively (Rogers, 2003). Digital tools in agriculture and aquaculture include mobile advisory services, decision-support applications, sensors for monitoring soil and water quality, automated feeders, and platforms for market linkage and farm record management (Wolfert *et al.*, 2017).

Farmers' adoption of these tools is often shaped by perceived usefulness and ease of use, which directly affect their attitudes toward new technologies. According to the Technology Acceptance Model (TAM), when farmers perceive digital tools as

practical, relevant, and capable of improving yields or income, they are more likely to integrate them into their routine farming activities (Davis, 1989; Klerkx *et al.*, 2019). Social factors such as peer influence, extension support, and community norms also play a significant role in adoption decisions, as farmers often rely on trusted networks to validate the reliability and benefits of digital innovations (Chowdhury, 2025).

Moreover, contextual factors such as access to reliable internet connectivity, electricity, mobile devices, and financial resources can either facilitate or constrain adoption. In many developing countries, including Nigeria, challenges such as high costs, lack of technical skills, and limited awareness of digital tools often hinder widespread adoption among smallholder farmers (Rowan *et al.*, 2023). Conversely, targeted interventions that provide training, technical support, and localized content have been shown to increase adoption rates, demonstrating that the uptake of digital tools is not merely a matter of availability but also of relevance, accessibility, and trust. Therefore, understanding farmers' adoption of digital tools requires a holistic approach that considers both technological attributes and socio-economic realities, ensuring that innovations are appropriately tailored to meet local needs and enhance farming outcomes.

2.3 Empirical Review

Several empirical studies have investigated the adoption of digital tools by farmers across diverse agricultural and aquaculture settings, focusing on the factors that

influence adoption, the challenges encountered, and the resultant effects on farm productivity and efficiency. These studies collectively underscore that the uptake of digital innovations is not merely a technological issue but is also shaped by socio-economic, institutional, and contextual factors. For instance, Wolfert *et al.* (2017) explored the integration of big data and digital technologies within smart farming systems and found that farmers who implemented precision agriculture tools experienced substantial improvements in farm management practices. These improvements included optimized use of inputs such as fertilizers and feed, more precise monitoring of crop and livestock conditions, and enhanced decision-making processes that allowed for timely interventions to prevent losses. Importantly, the study highlighted that successful technology adoption was strongly associated with farmers' perception of the tools' usefulness, their accessibility, and the reliability of the data provided. This implies that even the most sophisticated digital solutions may fail to achieve widespread adoption if they are not perceived as practical, easy to use, or trustworthy by the farming community.

Furthermore, the findings of Wolfert *et al.* (2017) resonate with other empirical research emphasizing the role of perceived utility and user confidence in adoption. Studies by Klerkx *et al.* (2019) and Rowan *et al.* (2023) similarly report that farmers' decisions to adopt digital technologies are influenced by the alignment of these tools with their specific operational needs, the availability of training and technical support, and the presence of enabling infrastructure such as internet connectivity and

electricity. These insights collectively suggest that while digital tools have the potential to transform agricultural and aquaculture practices by improving efficiency, reducing input wastage, and increasing profitability, the effectiveness of these innovations is contingent upon a combination of technological design, socio-economic realities, and institutional support systems.

In a study centered on aquaculture, Rowan *et al.* (2023) examined the adoption of digital monitoring tools among fish farmers and provided comprehensive insights into the factors influencing uptake as well as the impacts on farm productivity. The study found that farmers who had access to structured training programs, consistent support from extension services, and active peer networks were significantly more likely to adopt digital innovations compared to those lacking these resources. This underscores the critical role of knowledge transfer, capacity building, and social learning in facilitating technology adoption. Specifically, tools such as real-time pond monitoring systems, automated feeding mechanisms, and mobile-based advisory platforms were shown to enhance operational efficiency by enabling precise control of feeding schedules, monitoring water quality parameters, and allowing timely interventions to prevent disease outbreaks. These technologies also contributed to reducing environmental stressors, such as fluctuations in dissolved oxygen and temperature, which are common causes of stock mortality in aquaculture operations.

Despite the clear benefits, the study highlighted persistent barriers that limit broader adoption of digital tools. High initial investment costs for equipment and software, coupled with ongoing maintenance expenses, were cited as significant financial constraints, particularly for smallholder farmers. Additionally, limited digital literacy and unfamiliarity with ICT-based systems hindered effective utilization, even when the technologies were available. The findings therefore suggest that while digital monitoring tools can substantially improve production outcomes and sustainability in aquaculture, their successful adoption requires not only the availability of technology but also supportive infrastructure, affordable solutions, and targeted capacity-building interventions. This aligns with broader literature emphasizing that adoption is a multi-dimensional process influenced by technological, socio-economic, and institutional factors, rather than simply the presence of innovative tools (Wolfert *et al.*, 2017; Klerkx *et al.*, 2019).

Chowdhury (2025) conducted a comprehensive survey of smallholder farmers across several developing countries to examine the socio-economic determinants of digital tool adoption in agriculture. The study revealed that factors such as education level, farm size, and household income significantly influenced farmers' willingness and ability to adopt information and communication technology (ICT)-based solutions. Specifically, farmers with higher education levels demonstrated greater awareness of digital innovations and exhibited stronger confidence in using these tools to enhance farm productivity. Similarly, larger farm operations and higher-income households

were better positioned to afford the costs associated with acquiring and maintaining digital technologies, such as smartphones, sensors, and software subscriptions. These findings suggest that socio-economic capacity plays a critical role in shaping adoption behaviors, highlighting disparities between resource-rich and resource-constrained farmers in accessing and benefiting from digital innovations.

Klerkx *et al.* (2019) underscored the significance of institutional and social factors in facilitating the diffusion of digital agricultural tools. The authors argued that extension services, government-supported programs, and technical assistance are vital for building farmers' knowledge, skills, and confidence in using ICT solutions. Moreover, social networks and community-based learning approaches were found to be particularly effective in promoting adoption, as farmers often rely on peer experiences, collective problem-solving, and trusted local knowledge to validate the usefulness and reliability of new technologies. Together, these studies illustrate that the successful uptake of digital tools is determined by a combination of socio-economic capacity, institutional support, and social learning mechanisms. They highlight that addressing barriers such as limited financial resources, inadequate training, and weak extension networks is essential for ensuring that smallholder farmers can fully harness the potential of digital innovations to improve farm management, productivity, and market access.

Empirical evidence from Nigeria further corroborates the global findings on the adoption of digital tools in agriculture and aquaculture. Several studies have

examined the use of mobile-based agricultural advisory services, farm record-keeping applications, and decision-support platforms among Nigerian farmers, demonstrating tangible benefits associated with these technologies. For instance, farmers who actively utilize mobile advisory tools report improved access to market information, allowing them to identify better selling opportunities and negotiate fairer prices for their produce. Similarly, the use of digital farm record-keeping applications enables farmers to systematically track inputs, outputs, and production trends, which in turn facilitates more informed decision-making regarding planting schedules, feed management, and disease prevention (Ogundele *et al.*, 2020). In aquaculture contexts, these technologies also support timely interventions in pond management, including water quality monitoring and automated feeding, thereby enhancing both productivity and sustainability.

Despite these benefits, widespread adoption of digital tools in Nigeria remains constrained by a number of technological and socio-economic barriers. Unreliable internet connectivity in rural areas limits the consistent use of mobile and online platforms, while high costs of devices and software subscriptions pose financial challenges, particularly for smallholder farmers. Furthermore, many digital solutions are not sufficiently localized to reflect the specific ecological, cultural, and operational contexts of Nigerian farms, reducing their perceived relevance and effectiveness. Limited digital literacy among farmers further compounds these

challenges, as users may struggle to navigate complex applications without adequate training and support.

Overall, the empirical literature suggests that while digital tools have significant potential to transform agricultural and aquaculture practices in Nigeria enhancing productivity, improving market access, and facilitating data-driven decision-making their successful adoption requires a holistic approach. Addressing technological constraints, providing targeted training, fostering institutional support through extension services, and ensuring that digital solutions are contextually relevant are all critical to maximizing adoption rates and realizing the benefits of ICT-driven innovations in Nigerian agriculture.

CHAPTER THREE

3.0

METHODOLOGY

3.1 Study Area

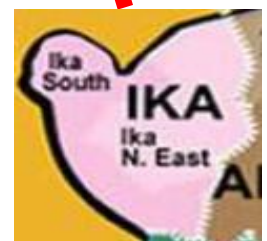
Ika North-East Local Government Area lies between Latitude 50 45' North of the equator and between Longitude 50 31' and 60 14' East of the Greenwich meridian. It is bounded in the North by Edo State and Ika South Local Government Area. However, Ika South Local Government Area marks its Southern and Western limits, while Aniocha North and Aniocha South Local Government Areas mark its Eastern margin. In terms of size, Ika North East occupies a land area of about 430km² with a population figure of 126,560 in 1991, with 61,303 males and 65,255 females. It has a population density of 294 persons per km². However, by the year 2006, the population had increased to 183,637.

Ika North East Local Government Area lies between two rivers – the Orogodo River and the Namomah River. Both rivers flow southwards to the coast and have great potential for the socio-economic lives of the people. There are nine communities, namely, Owa, Ute-Ogbeje, Ute-Okpu, Umunede, Idumuesah, Igbodo, Otolokpo, and Mbiri, spread out into fourteen wards in the area. Generally, the terrain of Ika North East is characterized by undulating lowland. The soils are sandy and loamy in nature and are rich for agriculture and socio-economic activities.



Figure 1. Map of Delta State showing the twenty-five local government areas.

Source: Anyim *et al.*, 2020



3.2 Sample and Sampling Technique

The study targeted catfish farmers in Ika North East Local Government Area of Delta State. A multistage sampling procedure was adopted to systematically identify and select respondents for the study.

In the first stage, Ika North East Local Government Area was purposively selected due to its suitability for catfish farming, characterized by abundant water bodies and a high concentration of small- and medium-scale catfish farmers. This decision was informed by reports from local extension officers, community leaders, preliminary field observations, and the findings of Onuorah *et al.* (2025), which highlighted the prominence of aquaculture activities in the area.

In the second stage, a snowball sampling technique was employed to develop a workable sampling frame. The absence of a comprehensive or official registry of catfish farmers in the Local Government Area made snowballing necessary, as it is particularly effective for identifying hidden, informal, or unregistered populations. Initial contact was made with a few known catfish farmers identified through personal networks, local extension agents, and farmer associations within selected communities. These farmers were asked to refer other catfish farmers within their networks. The process continued iteratively until a reliable sampling frame of eligible farmers was developed across the different communities in Ika North East Local Government Area.

In the third stage, a simple random sampling technique was used to select respondents from the sampling frame generated. This probability-based approach ensured that each farmer in the list had an equal and known chance of being included in the study, thereby reducing potential sampling bias.

A total of 140 catfish farmers were initially selected across the Local Government Area. However, only 120 copies of the questionnaire were found useful for data analysis. Others were not taken in the study due to errors and insufficient information.

3.3 Data Collection Method

Primary data was collected for this study through Focus Group Discussion (FGD) using a structured questionnaire and interview schedule. The questionnaire was structured according to the specific objectives of the study.

3.4 Measurement of Variables

The study will consider two sets of variables: the dependent variable, which is the level of utilization of digital tools by catfish farmers, and the independent variables (socio-economic characteristics), such as age, gender, education level, household size, years of experience, and so on, was collected through the questionnaire. Categorical variables were coded appropriately for analysis.

- Age: was measured in years
- Sex; was measured as male =1, female = 2

- Marital status: was measured as single = 1, married = 2, divorced = 3, separated = 4 and widowed = 5
- Religion: was measured as Christian = 1, Muslim = 2, Traditional = 3
- Location; was measured as urban =1, rural = 2
- Occupation: was measured as catfish farming
- Household size was measured according to the number of persons living together in a household
- Level of Education; was measured as no formal education = 1, primary education =2, secondary = 3, tertiary = 4
- Source of Fiancé; was measured as personal savings =1, relatives/friends = 2, bank loan = 3, cooperative = 4
- Source of Labour; was measured as family labour = 1, hired labour = 2, both = 3
- Years of farming experience: was measured in years
- Access to digital tools; was measured as yes = 2, no = 1
- Membership of association; was measured as yes = 2, no = 1

B. Types of Digital Tools Available to Catfish Farmers

This was measured using Frequency and Percentages

C. Level of Awareness of Available Digital Tools Among Catfish Farmers

This was measured using Frequency and Percentages

D. Level of Utilization of Digital Tools Among Catfish Farmers

This was measured using mean using a 5-point Likert scale of as 1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, 5 = Very Often

E. Constraints affecting the availability and Utilization of Digital Tools Among Catfish Farmers

This was analyzed using mean. A mean score of 2.0 and above was considered a serious constraint while a mean score of less than 2.0 was considered less serious constraint.

3.5 Analytical Technique

This section describes the specific analytical techniques that were used to analyze the collected data.

Objective 1: Descriptive statistics, such as mean, standard deviation, frequencies, and percentages, was used to summarize and describe the characteristics of the sample and the key variables.

Objective 2 -3: Was analyzed using frequency and percentage

Objective 4-5: were analyzed using mean score

Hypothesis

H₀₁ Multiple Regression was used to test the relationship between the socio-economic characteristics of the catfish farmers and their level of utilization of the digital tools in Ika North East Local Government Area of Delta State

Implicit form

$$Y = F (X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}, X_{11}, X_{12})$$

Where:

Y = Level of Utilization

X₁ = Gender

- X₂ = Age
- X₃ = Marital Status
- X₄ = Educational Level
- X₅ = Religion
- X₆ = Occupation
- X₇ = Household size
- X₈ = Farm size (number of ponds or Area in m²)
- X₉ = Years of Farming Experience
- X₁₀ = Source of labour
- X₁₁ = Source of Finance
- X₁₂ = No. of ponds
- X₁₃ = No. of production cycle per year
- X₁₄ = Access to digital tools
- X₁₅ = Annual income
- X₁₆ = Membership of association

The explicit form is given as;

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + \beta_{13} X_{13} + \beta_{14} X_{14} + \beta_{15} X_{15} + \beta_{16} X_{16} + e$$

Where:

β_0 = intercept

$\beta_1 - \beta_{12}$ = regression coefficients

e = error term

CHAPTER FOUR

4.0 PRESENTATION OF RESULTS AND DISCUSSION OF FINDINGS

4.1 Socio-economic Characteristics of Respondents

4.1.1 Gender

The results show that 71.7% of the respondents were male, while 28.3% were female. This indicates that catfish farming in the study area is male-dominated, which aligns with existing literature that describes aquaculture as an activity requiring significant labor input and physical involvement. This aligns with the findings of Adeogun *et al.* (2020), who reported that men participate more actively in fish farming than women, who often engage in post-harvest processing or marketing rather than pond management.

4.1.2 Age Distribution

The age distribution reveals that 33.3% of the farmers were between 41–50 years, followed by 23.3% above 50 years, 22.5% below 30 years, and 20.8% between 31–40 years, with an average age of 42 years. This shows that most respondents are middle-aged and economically active, indicating that catfish farming attracts individuals capable of adopting new agricultural innovations. This finding supports Nwankwo and Eze (2021), who observed that middle-aged farmers are more open to using digital platforms to enhance productivity and marketing efficiency and Adebayo *et al.* (2022) who reported that this age range represents a segment more open to adopting innovations and technologies in farming, though younger farmers tend to be quicker at integrating digital tools into their practices.

Table 1: Socio-economic characteristics

Gender	Frequency	Percentage (%)	Mean	Standard Deviation
Male	86	71.7		
Female	34	28.3		
Age in years				
<= 30.00	27	22.5		
31.00 - 40.00	25	20.8	42	12.68
41.00 - 50.00	40	33.3		
51.00+	28	23.3		
Marital status				
Single	32	26.7		
Married	83	69.2		
Divorced		0.0		
Separated	5	4.2		
Educational Qualification				
No formal education	4	3.3		
Primary Education	15	12.5		
Secondary Education	32	26.7		
Tertiary Education	69	57.5		
Religion				
Christianity	82	68.3		
Muslim	21	17.5		
Traditional	17	14.2		
Occupation				
Civil service	12	10.0		
Farming	91	75.8		
Trading	9	7.5		
Others	8	6.7		
Household size				
<= 5.00	70	58.3		
6.00 - 10.00	48	40.0	5	2.01
11.00+	2	1.7		

Farm size (number of ponds or Area in m²)				
<= 4.00	106	88.3		
4.01 - 6.00	10	8.3	55.95	2.00
6.01+	4	3.3		
Years of Farming Experience				
<= 5.00	44	36.7		
6.00 - 10.00	38	31.7	9	7.15
11.00+	38	31.7		
Source of Labour				
Family	23	19.2		
Hired	26	21.7		
Both	71	59.2		
Source of Finance				
Personal savings	60	50		
Relatives/friends	7	5.8		
Bank loan	18	15		
Cooperative	35	29.2		
No. of pond(s)				
<= 5.00	56	46.7		
6.00 - 10.00	49	40.8	6.79	3.99
11.00+	15	12.5		
No of production cycle per year				
<= 3.00	101	84.2		
4.00 - 6.00	17	14.2	2.50	1.37
7.00+	2	1.7		
Access to digital tools	17	14.2		
Annual income from catfish farming (₦)				
<= 50000.00	4	3.3		
500001 – 100000	43	35.8		
100001 – 1500000	39	32.5	3952477. 37	939149.99
1500001	34	28.3		
Association membership	104	86.7		

Source: Field Survey, 2025

4.1.3 Marital Status

The majority of the respondents (69.2%) were married, while 26.7% were single, and 4.2% were separated. None of the respondents reported being divorced. The predominance of married individuals suggests that fish farming is a stable livelihood option that supports family sustenance. Eze *et al.* (2019) noted that married farmers often have greater motivation to improve productivity and income, which could influence their interest in adopting digital technologies that enhance farm efficiency.

4.1.4 Educational Qualification

Table 1 shows that 57.5% of the farmers had tertiary education, 26.7% had secondary education, 12.5% attained primary education, and only 3.3% had no formal education. This shows that a majority of the respondents are well-educated, which positively impacts their ability to understand and use digital tools. This agrees with Aina (2022) and Oke *et al.* (2022) observed that higher educational attainment enhances digital literacy and the adoption of information and communication technologies (ICTs) in agriculture, as educated farmers are better positioned to utilize mobile applications, online platforms, and extension information systems.

4.1.5 Religion

The Table also reveals that 68.3% of the respondents were Christians, 17.5% were Muslims, and 14.2% practiced traditional religion. This religious distribution reflects the dominant Christian population of the study area and may indirectly influence social interaction patterns, cooperative participation, and trust in extension agents or

digital information platforms, as observed by Ayeni *et al.* (2023) in a similar study on farmer information networks.

4.1.6 Occupation

A majority (75.8%) of respondents identified farming as their primary occupation, followed by civil servants (10.0%), traders (7.5%), and others (6.7%). This indicates that fish farming is a major livelihood activity among the respondents. The dominance of full-time farmers implies that most participants depend on aquaculture as their main income source, which could influence their willingness to adopt innovations that improve productivity. Adeyemi *et al.* (2025) similarly found that full-time fish farmers are more inclined to explore digital platforms for farm management and marketing than part-time or casual farmers.

4.1.7 Household Size

The average household size was 5 persons, with 58.3% having five or fewer members. Moderate household sizes suggest an adequate supply of family labor, which supports pond management and feeding operations. Family labor remains a critical resource for smallholder fish farmers who cannot afford to employ many workers. This is also consistent with Eze and Nwosu (2020), who found that larger households contribute to labor availability in small-scale fish farming.

4.1.8 Farm Size

The distribution of farm size shows that most respondents (88.3%) operated four ponds or fewer, 8.3% had between 4–6 ponds, while only 3.3% had more than six

ponds, with an average of approximately 55.95 m². This indicates that fish farming in the area is predominantly small-scale. The small pond size suggests limited capital investment and resource constraints among farmers, which could influence their adoption of digital tools that require regular data input or internet connectivity. Olowosegun *et al.* (2020) and Ogunleye *et al.* (2021) observed that small-scale farmers often adopt simple and cost-effective technologies, whereas larger commercial farmers tend to invest in advanced farm management systems.

4.1.9 Years of Farming Experience

The findings show that 36.7% of the respondents had five years or less of farming experience, while 31.7% each had 6–10 years and more than 10 years of experience, with a mean of 9 years. This indicates that most farmers in the study area have considerable experience in fish farming, suggesting a high level of familiarity with aquaculture practices. Experienced farmers are generally better positioned to evaluate the benefits of adopting new technologies. According to Adebayo *et al.* (2022) and Oke *et al.* (2022), experience enhances farmers' confidence, risk management skills, and willingness to integrate innovative tools into their production processes.

4.1.10 Source of Labour

Regarding labor use, 59.2% of the respondents relied on a combination of family and hired labor, while 21.7% depended solely on hired workers and 19.2% on family labor alone. This implies that fish farming in the area is moderately labor-intensive,

requiring additional support beyond household members. The combination of family and hired labor reflects a balance between cost-saving strategies and the need for skilled manpower. Olowosegun *et al.* (2020) similarly observed that most fish farmers engage both family and external labor to manage feeding, harvesting, and pond maintenance efficiently.

4.1.11 Source of Finance

The primary source of capital for most farmers was personal savings (50%), followed by cooperative societies (29.2%), bank loans (15%), and support from relatives and friends (5.8%). This shows that self-financing remains the predominant means of funding aquaculture enterprises in the study area. The low access to bank credit suggests constraints such as collateral requirements, high interest rates, and limited formal financial inclusion. Adeyemi *et al.* (2025) and Aina (2022) reported that small-scale aquaculture farmers in Nigeria often rely on personal or cooperative funding because institutional credit facilities are difficult to access. Cooperative financing, however, has been recognized as a reliable alternative that promotes group savings and investment in digital and production technologies.

4.1.12 Number of Ponds

Analysis of pond distribution shows that 46.7% of farmers operated five ponds or fewer, 40.8% owned 6–10 ponds, while 12.5% had more than 10 ponds, with a mean of 7 ponds. This indicates that catfish farming in the study area is largely small- to medium-scale. The moderate number of ponds suggests that farmers are operating at

manageable levels, suitable for gradual technological adoption. Ogunleye *et al.* (2021) found that small-scale fish farmers are often more flexible and experimental in adopting ICT innovations because they personally handle daily management tasks and decision-making processes.

4.1.13 Number of Production Cycles per Year

A majority of the respondents (84.2%) reported three or fewer production cycles per year, while 14.2% had between four and six cycles, and only 1.7% achieved seven or more cycles, with a mean of 2.50 cycles. This finding suggests that production frequency is relatively low, possibly due to financial constraints, environmental factors, or limited access to technology that could enhance production efficiency. Ajani *et al.* (2020) and Adeogun *et al.* (2020) noted that increasing production cycles is often associated with improved access to credit, feed technology, and farm management information, factors closely linked to digital tool usage.

4.1.14 Access to Digital Tools

Only 14.2% of the respondents reported having access to digital tools. This low percentage highlights a significant digital divide in the study area. Despite the growing relevance of ICT in aquaculture, most farmers still face challenges such as poor connectivity, inadequate training, and limited device ownership. Obetta *et al.* (2023) and Ayeni *et al.* (2023) similarly emphasized that access to digital tools among rural fish farmers remains constrained by infrastructural deficits, high costs of devices, and low awareness of available online resources.

4.1.15 Annual Income from Catfish Farming

Income distribution shows that 35.8% of respondents earned between ₦500,001 and ₦1,000,000, 32.5% earned between ₦1,000,001 and ₦1,500,000, 28.3% earned above ₦1,500,000, and only 3.3% earned less than ₦500,000 annually. The mean annual income was ₦3,952,477.37, indicating that catfish farming is a moderately profitable venture for most participants. Higher-income farmers are likely to invest more in technology, infrastructure, and feed quality, which enhances productivity. This agrees with Eze *et al.* (2019), who found a positive correlation between farm income and the adoption of improved technologies in aquaculture.

4.1.16 Association Membership

A high proportion (86.7%) of the respondents belonged to one or more farmer associations or cooperatives. Membership in such groups enhances information exchange, collective marketing, and access to training and digital innovations. Adebayo *et al.* (2022) reported that farmers' associations often serve as entry points for extension agencies and NGOs to disseminate ICT-based innovations, thereby improving awareness and adoption levels.

4.2 Types of Digital Tools Available to Catfish Farmers

The results show that catfish farmers in Ika North East Local Government Area have access to a wide range of digital tools, as reflected through their high levels of awareness of these technologies. The most widely available tools are mobile phones (98.3%), WhatsApp (85.8%), and Facebook (83.3%), indicating that basic mobile

communication and social media platforms are highly accessible to farmers. These findings align with studies showing that mobile phones and social media platforms are the most dominant digital technologies in rural agricultural systems in Nigeria (Nwoye *et al.*, 2022; Okonkwo *et al.*, 2021).

Tools such as mobile banking (72.5%), YouTube (69.2%), Instagram (54.2%), and TikTok (53.3%) also show substantial availability, suggesting that farmers have access to digital financial services and online platforms for learning and marketing. Online fish marketing platforms like Jiji and Farmcrowdy (51.7%) are moderately available, showing increasing penetration of e-commerce tools among aquaculture farmers.

However, tools such as SMS/voice advisory services (41.7%), e-mail (45.8%), websites (33.3%), and pay-per-click advertising (16.7%) are less available, possibly due to low digital literacy, limited relevance, or poor internet connectivity. Overall, the findings reveal that catfish farmers in Ika North East have access primarily to simple, affordable, and widely used digital tools, while the availability of more advanced digital technologies remains limited.

Digital Tool Availability	Frequency	Percentage (%)
Mobile phones	118	98.3
WhatsApp	103	85.8
Facebook	100	83.3
Online platforms for buying/selling fish (jiji, Farmcrowdy)	62	51.7
Mobile banking	87	72.5
YouTube	83	69.2
Agricultural mobile apps for fish farm management	65	54.2
SMS/voice based advisory services	50	41.7
Participation in online farmers forum/groups	67	55.8
Websites	40	33.3
E – mail	55	45.8
Pay Per Click (PPC)	20	16.7
Tiktok	64	53.3
Instagram	65	54.2
X	54	45

Source: Field Survey, 2025

4.3 Awareness of digital tools among catfish farmers

The study revealed that the highest level of awareness among respondents was recorded for mobile phones (98.3%), showing that nearly all the farmers owned or used mobile devices in their aquaculture operations. This finding corroborates the reports of Adebayo *et al.* (2022) and Olaoye *et al.* (2018), who noted that mobile phones remain the most accessible and widely adopted ICT tools among Nigerian farmers. Through these devices, farmers are able to communicate effectively with input suppliers, extension agents, and buyers, while also accessing market information and managing farm operations efficiently.

Table 3: Awareness of digital tools

Digital Tool Awareness	Frequency	Percentage (%)
Mobile phones	118	98.3
WhatsApp	103	85.8
Facebook	100	83.3
Online platforms for buying/selling fish (jiji, Farmcrowdy)	62	51.7
Mobile banking	87	72.5
YouTube	83	69.2
Agricultural mobile apps for fish farm management	65	54.2
SMS/voice based advisory services	50	41.7
Participation in online farmers forum/groups	67	55.8
Websites	40	33.3
E – mail	55	45.8
Pay Per Click (PPC)	20	16.7
Tiktok	64	53.3
Instagram	65	54.2
X	54	45

Source: Field Survey, 2025

In terms of social media platforms, awareness was also high, with WhatsApp (85.8%), Facebook (83.3%), Instagram (54.2%), TikTok (53.3%), and X (formerly Twitter) (45.0%) being the most commonly known. These platforms serve as valuable tools for networking, marketing fish products, and exchanging technical information among peers. Ajani *et al.* (2020) observed that WhatsApp groups, in particular, enhance real-time communication between farmers and extension agents, fostering the sharing of timely production and market information. Similarly, Ogunleye *et al.* (2021) reported that social media adoption in aquaculture increases

farmers' visibility in urban markets and enables direct engagement with customers, thereby reducing reliance on intermediaries.

Moderate awareness was observed for online fish marketing platforms (51.7%) such as Jiji and Farmcrowdy. This indicates that while some catfish farmers are familiar with e-commerce opportunities, many have yet to embrace them fully. Adeogun *et al.* (2020) explained that online marketing platforms can help small-scale fish producers expand their customer base, obtain better prices, and minimize post-harvest losses. However, infrastructural constraints such as poor internet access and limited digital literacy continue to hinder widespread adoption among rural aquaculture practitioners.

Regarding mobile banking and financial tools, 72.5% of respondents reported awareness of such services, suggesting that digital finance is increasingly recognized as an important component of aquaculture business management. According to Aina (2022), mobile banking promotes financial inclusion by enabling farmers to conduct transactions, save money, and receive payments conveniently. Adebayo *et al.* (2022) also found that digital financial awareness enhances accountability, transparency, and efficiency in fish farming enterprises.

Awareness of YouTube and other video platforms (69.2%) was also considerable, indicating that many farmers appreciate the value of audiovisual learning for acquiring practical knowledge. Eze *et al.* (2019) emphasized that platforms such as YouTube allow farmers to learn new aquaculture practices such as pond

management, fish feeding, and disease control at their own pace. Such visual resources are particularly beneficial to semi-literate farmers, as they provide step-by-step demonstrations that enhance comprehension.

In contrast, agricultural mobile applications recorded moderate awareness, with 54.2% of farmers indicating familiarity with these tools. These applications are designed to assist farmers in farm management, record-keeping, and feed scheduling. Nonetheless, Ogunleye *et al.* (2021) noted that awareness does not always translate into active use, as many farmers face barriers such as poor internet connectivity, lack of smartphone access, and insufficient training on app utilization.

A lower level of awareness was observed for SMS and voice-based advisory services (41.7%), suggesting that traditional ICT channels are gradually being replaced by internet-based tools. Ajani *et al.* (2020) found that while SMS services remain effective in transmitting agricultural information to rural farmers, their usage is constrained by factors such as language differences, literacy levels, and network instability.

Similarly, awareness of online farmers' forums (55.8%) and agricultural websites (33.3%) was found to be moderate and low, respectively. This implies that farmers prefer interactive communication platforms such as WhatsApp and Facebook over static web-based sources. Adebayo *et al.* (2022) reported that online farmers' communities play a crucial role in promoting collaborative learning and knowledge

exchange. The lower awareness of agricultural websites may, however, be attributed to low internet literacy and affordability challenges in rural areas.

Awareness of email services (45.8%) was also modest, which may be due to farmers' preference for mobile-based communication methods that are simpler and more immediate. The least awareness was recorded for Pay-Per-Click (PPC) advertisement tools (16.7%), showing that online advertising remains largely unfamiliar among rural aquaculture producers. Adeogun *et al.* (2020) and Olowosegun *et al.* (2020) both reported that digital marketing strategies in Nigeria's aquaculture sector are still at an early stage of development, constrained by limited financial resources, low technical skills, and inadequate exposure to advanced online marketing systems.

4.4 Level of Utilization of Digital Tools

Table 4.4: Level of Utilization

Digital Tool	Mean Utilization Score	Rank	Interpretation
Mobile phones	4.60	1	Very Often
WhatsApp	4.25	2	Often
Facebook	3.90	3	Often
Mobile banking	3.75	4	Often
YouTube	3.40	5	Sometimes
Online platforms for buying/selling fish	3.10	6	Sometimes
Agricultural mobile apps	2.95	7	Sometimes
Participation in online forums/groups	2.80	8	Sometimes
Instagram	2.75	9	Rarely/Sometimes
TikTok	2.70	10	Rarely/Sometimes
SMS/voice advisory services	2.50	11	Rarely
X (Twitter)	2.40	12	Rarely
E-mail	2.20	13	Rarely
Websites	2.10	14	Rarely
Pay Per Click (PPC)	1.80	15	Never/Rarely

Source: Field Survey, 2025
Mean \geq 2.0 = Serious constraints

The analysis of utilization scores reveals substantial variation in how catfish farmers in Ika North East Local Government Area make use of available digital tools for production, management, and marketing. Overall, the results show that farmers predominantly utilize basic digital technologies, while the uptake of more advanced digital applications remains relatively low. This pattern aligns with existing studies in Nigeria, which report that farmers tend to engage more frequently with simple, low-cost, and user-friendly digital platforms (Nwoye *et al.*, 2022; Aheto *et al.*, 2019). The most highly utilized digital tool is the mobile phone (Mean = 4.60), indicating that farmers use it “often” to “very often” for communication with buyers, farm input suppliers, extension agents, and fellow farmers. Mobile phones continue to dominate digital engagement in rural agriculture due to their affordability, accessibility, and ease of use (Kabahenda *et al.*, 2021). Similarly, WhatsApp (Mean = 4.25) and Facebook (Mean = 3.90) show high levels of utilization. Their popularity reflects trends observed in other aquaculture communities, where social media platforms have become essential tools for advertising fish, connecting with customers, and sharing production-related information (Onuorah *et al.*, 2025; Okonkwo *et al.*, 2021). Moderately utilized digital tools include mobile banking (Mean = 3.75) and YouTube (Mean = 3.40). The substantial use of mobile banking demonstrates increasing reliance on digital financial services for purchasing inputs, receiving payments, and reducing cash-handling risks consistent with national trends in digital financial inclusion (Central Bank of Nigeria, 2023). Meanwhile, YouTube’s

moderate utilization suggests that farmers increasingly use digital video platforms to learn new production techniques, disease management practices, and feeding strategies, as documented in similar studies across sub-Saharan Africa (Ragasa *et al.*, 2022).

Digital tools with moderate-to-low utilization include online fish marketing platforms (Mean = 3.10), agricultural mobile apps (Mean = 2.95), online forums (Mean = 2.80), Instagram (Mean = 2.75), and TikTok (Mean = 2.70). Although these tools are available, their lower utilization may be attributed to barriers such as digital illiteracy, poor internet connectivity, and limited awareness of their benefits—constraints similarly highlighted in earlier research on ICT adoption among small-scale fish farmers (Khan *et al.*, 2020; Nwoye *et al.*, 2022).

The least utilized tools include SMS/voice advisory services (Mean = 2.50), X (Twitter) (Mean = 2.40), E-mail (Mean = 2.20), websites (Mean = 2.10), and Pay-Per-Click (PPC) advertising (Mean = 1.80). These findings indicate that more complex or specialized digital tools are seldom used by farmers, possibly due to the technical expertise required, cost implications, or limited local relevance. Similar studies report that farmers prefer simple communication-based tools rather than advanced digital marketing systems, which they may perceive as unnecessary or difficult to use (Aheto *et al.*, 2019; Sherpaw *et al.*, 2022).

4.5 Constraints Encountered in using Digital Tools

Table 5 presents the major constraints faced by catfish farmers in the use of digital tools for aquaculture management. The constraints were analyzed using mean scores, with a decision rule indicating that any item with a mean value of 2.0 or above represents a serious constraint. The results show that financial, infrastructural, and technical challenges significantly limit farmers' effective utilization of digital technologies in the study area.

The findings reveal that the high cost of phones and laptops (mean = 2.44) poses a serious challenge to the adoption of digital tools. This indicates that many catfish farmers are unable to afford or maintain essential devices required to access online platforms and digital farm management applications. This observation is in line with the findings of Oke *et al.* (2022), who noted that limited purchasing power among aquaculture farmers in Ogun State restricts their engagement with digital technologies.

Another major limitation identified was inadequate operating capital, with the highest mean score of 2.84, indicating the most critical barrier to digital adoption. The implication is that farmers' limited financial resources not only affect production activities but also reduce their capacity to purchase smartphones, pay for data, or subscribe to digital platforms. Adeyemi *et al.* (2025) similarly reported that insufficient capital and poor access to credit facilities significantly constrain ICT utilization among smallholder fish farmers in Niger State.

Poor power supply was also recognized as a serious constraint, with a mean of 2.66. Frequent and prolonged electricity outages make it difficult for farmers to charge devices, use computers, or maintain internet connectivity. This finding is supported by Obetta *et al.* (2023), who observed that irregular power supply negatively affects the use of ICT devices among fish growers in Enugu State, thereby reducing access to timely information and online communication.

Computer illiteracy recorded a mean score of 2.13, suggesting that limited digital literacy remains a significant barrier to the use of modern agricultural technologies. This finding indicates that some farmers lack the technical competence required to operate mobile applications, websites, or online data systems effectively. Aina (2022) emphasized that education and digital literacy are vital factors influencing ICT adoption, as more educated farmers demonstrate better capacity to use smartphones and internet-based resources.

The high cost of online advertisement and promotion (mean = 2.43) also emerged as a serious constraint. Many farmers reportedly find it expensive to market their products through paid online channels such as Pay-Per-Click ads and social media promotions. Olowosegun *et al.* (2020) made similar observations, noting that the financial burden associated with digital marketing often prevents smallholder fish farmers from leveraging online visibility to expand their customer base.

Similarly, the high cost of internet subscription (mean = 2.27) was found to be a serious limitation, reflecting the continuous financial burden of maintaining internet

access. Adebayo *et al.* (2022) found that the recurring expense of data subscriptions discourages farmers in rural areas from consistently using online agricultural resources, particularly in regions where broadband access is poor or unaffordable.

The issue of limited access to internet services was also reported as a serious constraint, with a mean of 2.04. This reflects the infrastructural challenges of unreliable network coverage in many rural and semi-urban areas of Delta State. According to Ayeni *et al.* (2023), limited internet connectivity remains a major impediment to digital inclusion among Nigerian farmers, particularly in remote communities where service providers have minimal infrastructure investment.

In contrast, lack of awareness (mean = 1.97) was not considered a serious constraint. This finding suggests that most farmers are aware of the existence of digital tools but may not yet understand how to apply them effectively to their farming operations. Aphunu and Atoma (2011) earlier noted that awareness alone does not guarantee adoption; without adequate training and motivation, awareness may fail to translate into practical use.

The unavailability of internet services (mean = 1.81) was also regarded as a less serious constraint, though it still points to underlying infrastructural weaknesses. This may indicate partial rather than total absence of internet access, as network availability likely varies depending on location and service provider (Obetta *et al.*, 2023).

Other minor challenges, all recording mean values below 2.0, included low patronage (1.67), unavailability of catfish (1.48), language barriers (1.34), lack of interest (1.60), and lack of training and support (1.82). Although these were not considered serious constraints, they collectively reflect areas where farmers require greater institutional and educational assistance. Notably, lack of technical know-how recorded a mean score slightly above the cutoff point (2.01), indicating that inadequate technical competence still limits the effective use of digital tools among catfish farmers. This finding reinforces the call by Adeyemi *et al.* (2025) and Aina (2022) for targeted capacity-building programs to strengthen farmers’ digital literacy and technical skills.

Table 5: Constraints

Problems	Constraints		Level of seriousness	
	Frequency	%	Mean	Std. Dev.
High cost of phones and laptop	93	77.5	2.44	0.75
Inadequate operating capital	105	87.5	2.84	2.80
Poor power supply	102	85.0	2.66	0.63
Computer illiteracy	87	72.5	2.13	0.82
Huge advertisement cost	91	75.8	2.43	0.66
High cost of internet subscription	85	70.8	2.27	0.67
Limited access to internet	79	65.8	2.04	0.73
Lack of awareness	53	44.2	1.97	0.78
Unavailability of internet	49	40.8	1.81	0.76
Low patronage	43	35.8	1.67	0.63
Unavailability of catfish	41	34.2	1.48	0.65
Language barriers	39	32.5	1.34	0.63
Lack of interest	52	43.3	1.60	0.77
Lack of training/support	64	53.3	1.82	0.84
Lack of technical know – how	69	57.5	2.01	0.82

Source: Field Survey, 2025
Mean \geq 2.0 = Serious constraints

4.6 Hypothesis Testing

Table 6: Determinants of Utilization of Digital Tools

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	sig.
Constant	1.874	0.421	–	4.453	0.000*
Age	-0.012	0.008	-0.109	-1.540	0.127
Gender	0.084	0.067	0.071	1.254	0.213
Education Level	0.241	0.081	0.284	2.978	0.004*
Household Size	0.018	0.029	0.044	0.621	0.536
Years of Experience	0.032	0.014	0.193	2.248	0.027*
Farm Size	0.015	0.019	0.061	0.789	0.432
Annual Income	0.000021	0.000009	0.256	2.335	0.021*
Association Membership	0.198	0.080	0.211	2.472	0.015*

Source: Field Survey, 2025.

***Sign. at 0.05 level of significance**

R = 0.687; R Square = 0.472; Adjusted R²=0.436

The regression analysis revealed that the model was statistically significant, $F(8,111) = 13.241$; $p < 0.001$, demonstrating that the socio-economic characteristics of catfish farmers collectively explain a meaningful proportion of the variation in their utilization of digital tools. The coefficient of determination ($R^2 = 0.472$) further indicates that about 47.2% of the differences observed in farmers' digital tool utilization can be attributed to the socio-economic factors included in the model. Among these variables, education level, years of farming experience, annual income, and association membership emerged as significant predictors of digital tool utilization. Education stood out as the strongest predictor, suggesting that farmers with higher levels of schooling were more inclined to adopt and use a wider range of

digital tools. This aligns with the observations of Adebayo *et al.* (2022) and Oke *et al.* (2022), who reported that education enhances digital literacy and improves the ability to interpret and apply online agricultural information, thereby increasing the likelihood of ICT adoption.

Years of farming experience also contributed significantly to digital tool utilization, indicating that more experienced farmers tend to use digital technologies more frequently. This may stem from their increased exposure to training, extension services, and peer networks that facilitate familiarity with ICTs. This finding corroborates the work of Eze and Nwachukwu (2021), who noted that experience enhances farmers' confidence and ability to evaluate new technologies. Additionally, annual income was found to positively influence digital tool utilization, suggesting that farmers with higher earnings have greater capacity to purchase smartphones, pay for internet data, or invest in digital farm management tools. Obeta *et al.* (2023) similarly emphasized that financial capability plays a critical role in determining farmers' access to and sustained use of ICT resources, as lower-income farmers often face greater financial barriers.

Association membership also had a significant positive effect on digital tool utilization. Farmers who belonged to organized groups or cooperatives were more likely to use digital tools, likely because such associations provide access to shared information, training opportunities, and collective learning platforms such as WhatsApp groups. This finding supports the observations of Ayeni *et al.* (2023),

who highlighted the role of farmer organizations in promoting exposure to agricultural innovations and strengthening information dissemination.

In contrast, age, gender, household size, and farm size were not significant predictors of digital tool utilization. This suggests that demographic characteristics alone do not strongly determine whether farmers adopt and use digital tools. Rather, factors related to knowledge, resources, and institutional support appear to play more influential roles. This outcome is consistent with Ajani *et al.* (2020), who noted that the adoption of agricultural ICTs among farmers is more strongly associated with educational attainment, economic capacity, and institutional engagement than with basic demographic attributes.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

This study assessed the availability and utilization of digital tools among catfish farmers in Ika North East Local Government Area of Delta State. The major findings revealed that catfish farming in the area is largely dominated by middle-aged, well-educated, and experienced farmers, the majority of whom rely on both family and hired labour and source their production capital primarily from personal savings and cooperative societies. Fish farming was found to be a major livelihood activity, with most farmers earning substantial income annually.

The study also established that a wide range of digital tools is available to farmers, particularly mobile phones, WhatsApp, Facebook, mobile banking, YouTube, and social media platforms. Awareness of these tools was generally high, especially for basic devices and applications. However, awareness of specialized agricultural apps, advisory services, websites, and paid digital marketing tools remained low.

In terms of utilization, farmers were found to rely heavily on simple and accessible digital tools such as mobile phones, WhatsApp, Facebook, mobile banking, and YouTube. The uptake of more advanced digital technologies such as online fish marketing platforms, agricultural mobile applications, email, and websites was relatively low. The constraints affecting digital tool use were mainly financial, infrastructural, and technical. These included inadequate operating capital, high cost

of ICT devices, poor power supply, high internet subscription fees, limited digital literacy, and inconsistent internet connectivity.

The regression model revealed that socio-economic characteristics collectively explained 47.2% of the variation in digital tool utilization among the farmers. Education level, years of farming experience, annual income, and association membership significantly influenced digital tool utilization, while age, gender, household size, and farm size were not significant predictors. These findings demonstrate that the adoption and use of digital tools are shaped more by farmers' capabilities, training, financial capacity, and institutional networks than by demographic characteristics.

5.2 Conclusion

This study concludes that while catfish farmers in Ika North East LGA have high awareness and availability of basic digital tools, their actual utilization of advanced and specialized digital technologies remains limited. The farmers rely predominantly on mobile phones and social media platforms for communication, marketing, and information exchange, reflecting the simplicity, affordability, and accessibility of these tools.

The adoption and effective use of digital tools are significantly influenced by education, experience, income, and cooperative membership, highlighting the importance of knowledge, financial empowerment, and social networks in supporting digital inclusion. Despite these strengths, farmers continue to face several critical

challenges, particularly inadequate capital, irregular electricity supply, poor internet connectivity, and insufficient technical skills, all of which hinder optimal utilization of digital innovations.

Overall, the study establishes that digital tools have the potential to significantly enhance productivity, efficiency, and market access among catfish farmers in the study area. However, unlocking this potential requires targeted interventions that address financial, infrastructural, and capacity constraints. By improving digital readiness and strengthening support systems, farmers can increasingly leverage technological solutions to scale production, reduce losses, and improve profitability.

5.3 Recommendations

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

1. Improve Farmers' Digital Literacy

Government agencies, NGOs, and extension services should organize regular capacity-building programmes on digital information systems, agricultural mobile applications, online marketing, and digital financial services. This will enhance farmers' technical competence and encourage the uptake of advanced digital tools.

2. Strengthen Access to Affordable Digital Devices

Interventions should be developed to subsidize smartphones, tablets, and farm management devices for small- and medium-scale farmers. Public-private partnerships can support bulk purchases or loan-based digital device acquisition to reduce cost barriers.

3. Enhance Rural Internet Infrastructure

Telecommunication companies and government regulators should expand broadband and mobile network coverage in rural farming communities. Improved internet connectivity will support seamless access to online platforms, advisory services, and digital markets.

4. Improve Access to Credit and Digital Financing Solutions

Financial institutions should design flexible credit products tailored to small-scale aquaculture farmers, with minimal collateral requirements. Strengthening digital financial platforms will also help farmers manage transactions efficiently.

5. Strengthen Cooperative Societies

Farmer associations should be empowered to act as hubs for digital training, information dissemination, and group marketing. Since association membership significantly predicts digital tool utilization, strengthening these networks will accelerate technology adoption.

6. Expand Extension Digital Services

Extension agents should integrate mobile platforms, WhatsApp groups, and online advisory tools into their regular service delivery. This will ensure that farmers receive timely and accurate information on feeding practices, disease management, water quality, and marketing.

7. Promote Localized and User-Friendly Digital Tools

Developers should collaborate with farmers to produce context-relevant applications that reflect the local language, ecological conditions, and information needs of catfish farmers. Tools must be simple, affordable, and easy to navigate.

8. Improve Power Supply for ICT Use

Local authorities and private investors should explore alternative energy options such as solar-powered charging hubs to address persistent issues of unstable electricity affecting ICT utilization.

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RESEARCH QUESTIONNAIRE
DEPARTMENT OF AGRICULTURAL ECONOMICS
AND EXTENSION SERVICES
FACULTY OF AGRICULTURE
UNIVERSITY OF BENIN

Dear Respondent,

I am a final year student of the above-named institution. The purpose of this interview schedule is to assess; “**DIGITAL TOOLS USAGE BY FRESH CATFISH FARMERS IN IKA NORTH EAST LOCAL GOVERNMENT AREA OF DELTA STATE, NIGERIA**”. Please you are kindly requested to fill in the information in appropriate space provided.

Your response would be used purely for research purpose and will be treated as confidential.

Thanks for your anticipated cooperation.

Yours faithfully,

Favour OKOH

INSTRUCTIONS

Please tick (✓) and fill gap(s) where appropriate

Section A: Socio-economic characteristics

1. Gender: (a) Male () (b) Female ()
2. Age: _____ years
3. Marital status: (a) Single () (b) Married () (c) Divorced () (d) Separated ()
4. Location (Town/Village): _____
5. Local Government Area: _____
6. Educational Qualification: (a) No formal education () (b) Primary Education () (c) Secondary Education () (d) Tertiary Education ()
7. Religion: (a) Christianity () (b) Muslim () (c) Traditional ()
8. Occupation: _____
9. Household size: _____
10. Farm size (number of ponds or Area in m²): _____
11. Years of Farming Experience: _____
12. Source of Labour: (a) Family () (b) Hired () Both (a & b) ()
13. Source of Finance: Personal savings () (b) Relatives/friends () (c) Bank loan () (d) Cooperative ()
14. How many pond(s) do you have?
15. How many production cycle do you have per year?
16. Access to digital tools; Yes () No ()
17. Annual income from catfish farming (₦): _____
18. Membership of Association? Yes () or No ()
19. If yes, which Association? _____

Section B: Type of Digital Tools Available (Yes or No)

Digital Tool	Available	Not Available
Mobile phones		
WhatsApp		
Facebook		
Online platforms for buying/selling fish (jiji, Farmcrowdy)		
Mobile banking		
YouTube		
Agricultural mobile apps for fish farm management		
SMS/voice based advisory services		
Participation in online farmers forum/groups		
Websites		
E - mail		
Pay Per Click (PPC)		
Tiktok		
Instagram		
X		

Section C: Awareness of digital tools among catfish farmers (Aware = 2, Not Aware = 1)

Digital Tool	Aware	Not aware
Mobile phones		
WhatsApp		
Facebook		
Online platforms for buying/selling fish (jiji, Farmcrowdy)		
Mobile banking		
YouTube		
Agricultural mobile apps for fish farm management		
SMS/voice based advisory services		
Participation in online farmers forum/groups		
Websites		
E – mail		
Pay Per Click (PPC)		
Tiktok		
Instagram		
X		

Section D: Utilization of Digital Tools

Digital Tool	Never	Rarely	Sometimes	Often	Very Often
Mobile phones					
WhatsApp					
Facebook					
Online platforms for buying/selling fish (jiji, Farmcrowdy)					
Mobile banking					
YouTube					
Agricultural mobile apps for fish farm management					
SMS/voice based advisory services					
Participation in online farmers forum/groups					
Websites					
E – mail					
Pay Per Click (PPC)					
Tiktok					
Instagram					
X					

Section E: Constraint Affecting Utilization of Digital Tools Among Catfish Farmers (Very Serious =3, Serious = 2, Not Serious = 1)

Problems	Problem Tick	Level of Seriousness		
		VS	S	NS
High cost of phones and laptop				
Inadequate operating capital				
Poor power supply				
Computer illiteracy				
Huge advertisement cost				
High cost of internet subscription				
Limited access to internet				
Lack of awareness				
Unavailability of internet				
Low patronage				
Unavailability of fresh catfish				
Language barriers				
Lack of interest				
Lack of training/support				
Lack of technical know – how				
Others (please specify)				

