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# PRECISION **AGRICULTURE**

T O

# RURAL LIVELIHOODS

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GOVERNANCE AND INCOME DYNAMICS  
IN DEVELOPING ECONOMIES

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EDITOR

Dr. Otniel Vázquez Peralta



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**FROM PRECISION AGRICULTURE TO RURAL  
LIVELIHOODS: GOVERNANCE AND INCOME  
DYNAMICS IN DEVELOPING ECONOMIES- 2026**

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**ISBN: 978-625-92209-5-6**

**DOI: 10.5281/zenodo.20027578**

May / 2026

Ankara / Türkiye



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(The Licence Number of Publicator: 2014/31220)

E mail: [info@ispecbooks.com](mailto:info@ispecbooks.com)

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ISPEC Publishing House – 2026©

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## **PREFACE**

This volume brings together a collection of scholarly contributions that examine key issues in agricultural development, rural livelihoods, and governance in developing economies. As global challenges such as food insecurity, environmental degradation, and economic inequality continue to intensify, the role of agriculture in supporting sustainable development and improving rural wellbeing has become increasingly significant.

The chapters in this book address important themes related to agricultural innovation, institutional frameworks, and income generation. The discussion on precision agriculture highlights both the opportunities and constraints faced by developing countries in adopting advanced farming technologies. The analysis of forest governance provides valuable insights into the dynamics of power, participation, and sustainability in rural resource management. In addition, the evaluation of agricultural extension programs emphasizes their impact on income generation and livelihood improvement among smallholder farmers.

By adopting an interdisciplinary perspective, this volume integrates insights from agricultural economics, rural development studies, and governance research. It contributes to academic discourse while also offering practical implications for policymakers, development practitioners, and researchers working to enhance agricultural productivity and rural resilience.

It is hoped that this book will serve as a valuable resource for scholars and practitioners interested in agricultural development and rural transformation, while encouraging further research on inclusive and sustainable strategies for improving livelihoods in developing regions.

**Editorial Team**  
**May, 2026**  
**Türkiye**

**CHAPTER 1**  
**PRECISION AGRICULTURE: CONSTRAINTS FOR**  
**AGRICULTURAL-BASED DEVELOPING**  
**COUNTRIES**

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## **INTRODUCTION**

The history of agriculture marks a crucial turning point in human civilization, starting with the Neolithic Revolution and developing through ongoing technological and scientific progress. A major milestone was the Green Revolution, which significantly boosted global food output by creating high-yield crop varieties, expanding irrigation infrastructure, and extensively utilizing chemical fertilizers and pesticides (Foley et al., 2011; Tilman et al., 2002). The Food and Agriculture Organization reports that worldwide cereal output exceeded 3 billion tonnes in 2025–2026, primarily fueled by key crops like rice, wheat, and maize. Despite these successes, global food systems continue to face significant challenges, as over 295 million individuals are suffering from severe food insecurity resulting from conflict, climate change, and economic turbulence (FAO, 2019). These obstacles highlight the pressing requirement for more effective, robust, and sustainable farming methods.

In recent years, precision agriculture has developed into a contemporary and data-oriented management strategy. It encompasses gathering, processing, and analyzing temporal, spatial, and individual data, which are combined with other pertinent information to enhance farm management choices (Gebbers & Adamchuk, 2010; Zhang et al., 2002). The swift advancement of precision agriculture is fueled by various interlinked elements associated with productivity, sustainability, and technological growth. The growing global population and increasing food demand require greater agricultural production without enlarging arable land (Gebbers & Adamchuk, 2010). Concurrently, increasing resource limitations—especially the shortage of water, fertilizers, and energy—have prompted the implementation of site-specific management strategies that enhance input efficiency and reduce waste (Zhang et al., 2002). Environmental issues such as soil degradation, climate change, and pollution from excessive agrochemical application have hastened the transition to precision farming systems that minimize ecological effects while sustaining productivity (Tilman et al., 2011). Nonetheless, the implementation of precision agriculture in developing nations encounters various significant obstacles.

Smallholder farming systems, prevalent in these areas, frequently do not have the financial means to invest in sophisticated technologies like GPS guided machinery, sensors, and data analysis tools (Lowenberg-DeBoer & Erickson, 2019). Moreover, insufficient infrastructure such as weak internet access, unstable power supply, and subpar extension services greatly hinders the execution of digital agriculture projects (Klerkx et al., 2019). Farmer's restricted technical knowledge and digital literacy inhibit the efficient utilization of these technologies, while divided land ownership diminishes economic viability and scalability (Finger et al., 2019). This chapter focuses on exploring the primary economic, technical, and institutional barriers that impact the efficiency of precision agriculture in developing nations. It emphasizes challenges like high upfront investment expenditures, reliance on foreign technologies, maintenance challenges, and restricted farmer abilities. Additionally, it tackles wider market issues, such as price volatility stemming from concurrent production rises and inadequate value addition mechanisms. Grasping these limitations is crucial for creating context-relevant, sustainable, and inclusive approaches to boost the adoption and enduring advantages of precision agriculture.

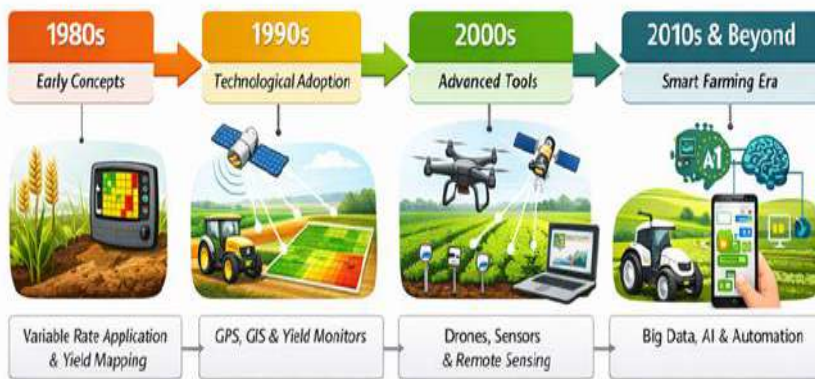
## **1. CONCEPT AND EVOLUTION OF PRECISION AGRICULTURE**

### **1.1 Concept of Precision Agriculture**

Precision agriculture is a data-oriented farming method that addresses spatial and temporal variability in fields to enhance resource utilization, productivity, and environmental sustainability (Gebbers & Adamchuk, 2010; Zhang et al., 2002). It is founded on the understanding that characteristics of soil, nutrient levels, water accessibility, and crop development differ across fields, necessitating targeted management approaches instead of uniform techniques (McBratney et al., 2005). This system combines cutting-edge technologies like GPS, GIS, remote sensing, sensors, drones, and data analytics to gather and evaluate real-time field data for effective decision-making (Zhang et al., 2002; Klerkx et al., 2019). Precision agriculture enhances the efficiency of input usage like fertilizers, water, and pesticides, leading to lower production costs and reduced environmental effects (Gebbers & Adamchuk, 2010).

## **1.2 Historical development of Precision Agriculture**

Precision agriculture has transformed from conventional uniform farming to a contemporary, technology-oriented approach (Zhang et al., 2002). It started in the 1980s when spatial variability was acknowledged and site-specific management practices were developed (Figure 1; McBratney et al., 2005). During the 1990s, tools like GPS, GIS, and yield monitors facilitated precise collection and analysis of field data (Zhang et al., 2002). The 2000s saw the combination of remote sensing and variable rate technologies to enhance farm management effectiveness (Gebbers & Adamchuk, 2010). In the 2010s, digital technologies such as drones, sensors, and big data analytics significantly enhanced precision agriculture (Klerkx et al., 2019).



**Figure 1.** Historical Development of Precision Agriculture (Source: Foley et al., 2011; FAO, 2019)

## **1.3 Precision Agriculture and Related Countries**

Precision agriculture is widely implemented in both developed and developing countries, although the level of adoption varies significantly across different areas. Nations such as the United States, Canada, Australia, and Germany lead in precision agriculture due to their sophisticated technological frameworks, widespread agricultural practices, and strong institutional support (Gebbers & Adamchuk, 2010). These countries extensively use GPS-guided tools, drones, and data analysis for efficient agricultural management.

Conversely, nations like India, Brazil, and China are slowly embracing precision agriculture, spurred by rising food needs and technological progress, despite ongoing issues like small farm sizes, limited funding, and insufficient infrastructure (Klerkx et al., 2019).

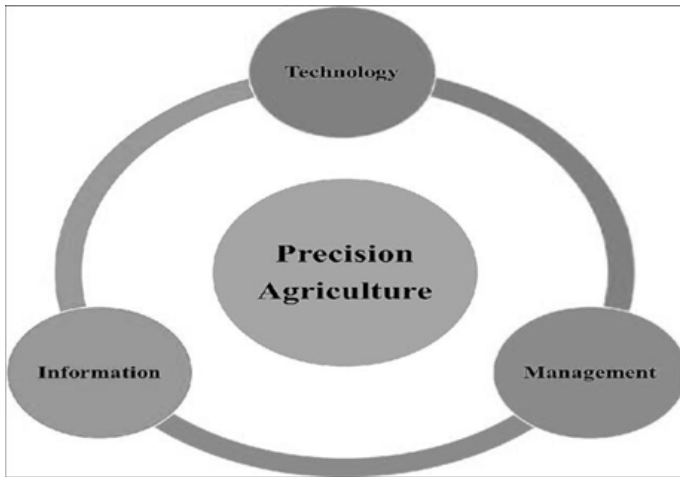
### **1.4 Contribution of Precision Agriculture**

Precision agriculture has greatly impacted contemporary farming by improving productivity, resource utilization, and ecological sustainability. By facilitating site-specific control of inputs like fertilizers, water, and pesticides, it minimizes input waste while enhancing crop yield and quality (Gebbers & Adamchuk, 2010). Employing cutting-edge technologies such as GPS, sensors, and data analytics enhances decision-making and the efficiency of farm management (Zhang et al., 2002). Moreover, precision agriculture aids in reducing environmental effects by decreasing nutrient leaching, soil deterioration, and greenhouse gas emissions (Tilman et al., 2011). It further adds to economic advantages by reducing production expenses and boosting farmers' profitability. In general, precision agriculture facilitates sustainable agricultural intensification and is essential for maintaining global food security. Precision agriculture contributes to global economic growth by improving efficiency and productivity. It can reduce input costs by 10–20% and increase crop yields by 5–15% (Lowenberg-DeBoer & Erickson, 2019). At a broader level, the adoption of precision technologies can contribute approximately 1–2% growth in agricultural GDP in advanced farming systems (World Bank, 2019).

## **2. TECHNOLOGY DEPENDENCY OF PRECISION AGRICULTURE**

### **2.1 Components of Precision Agriculture**

The major components of precision agriculture include information, technology, and management, which are integrated to optimize agricultural production (Figure 2; GeoPard, 2023).



**Figure 2.** Major components of Precision Agriculture (Tom et al., 2024).

**Information:** Information is a fundamental component of precision agriculture, involving the collection of data on soil, weather, crops, and other factors influencing agricultural production. This data is obtained through various sources, including sensors, drones, satellites, and ground-based equipment. Once collected, the data is analyzed using advanced software and algorithms to generate actionable insights, enabling farmers to make informed decisions regarding planting, fertilization, irrigation, and harvesting (GeoPard, 2023).

### ***Technology***

Technology is a key component of precision agriculture, encompassing tools such as the Global Positioning System (GPS), drones, robotics, and advanced machinery. These technologies enable the automation of agricultural processes, reducing labor requirements and improving operational efficiency (GeoPard, 2023).

### ***Management***

Management is the third key component of precision agriculture, involving the use of advanced software and tools to manage farm operations, optimize resource use, and minimize waste.

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It also incorporates sustainable agricultural practices to ensure environmental protection and long-term productivity (GeoPard, 2023).

## **2.2 Technology Related to Precision Agriculture**

It includes a number of technologies ranging from sensing systems that map crop and soil variability to guidance systems and variable-rate (VR) systems that dose agricultural inputs onto the field (Table 1).

**Table 1.** Commonly used technology and their uses

<b>Technology</b>	<b>Function</b>
GPS and GNSS	Provide exact location data for mapping and guidance.
Drones	Collect high-resolution images and data on crop health.
Remote Sensing	Satellites capture multispectral images showing plant vigor and stress.
Soil Sensors	Measure moisture, temperature, pH, and nutrient levels.
Automated Machinery	Tractors and sprayers equipped with Variable Rate Technology (VRT) and GPS for precise application.
IoT (Internet of Things)	Connect devices to central platforms for real-time monitoring.
GIS (Geographic Information Systems)	Analyse and visualise spatial data.
Data Analytics and AI	Analyse large datasets for insights and predictions.
Soil Moisture Probes and Nutrient Sensors	For real-time soil condition data.
Multispectral Cameras	For aerial crop monitoring.
Variable Rate Applicators	Spread seeds, fertilisers, and pesticides variably.
Farm Management Software	Platforms like Cropio, Trimble Ag, or John Deere Operations Centre.
Weather Stations	Provide localised weather data.

## **2.3 Nations Innovated Technology related to Precision Agriculture**

Nations such as the United States, Canada, Japan, Israel, China and the United Kingdom are playing a leading role in innovating technologies related to precision agriculture (Table 2).

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**Table 2.** Leading Precision Agriculture Companies and Their Origins

<b>Company</b>	<b>Country</b>	<b>Product Type</b>
AgJunction, Inc.	Canada	GPS technology and Automated Steering Systems
CropMetrics LLC.	United States	Precision Irrigation Management System Variable Rate Irrigation (VRI) Technology
Trimble, Inc.	United States	Precision Guidance & GPS System Automated Steering System Variable Rate Technology (VRT)
Raven Industries Inc.	United States	Cloud-Based Data Management Platform Autonomous Farming Technology
Deere and Company	United States	Smart Agricultural Machinery (tractors, harvesters, sprayers) Precision Planting System
Topcon Corporation	Japan	GNSS / Precision Positioning System Automated Steering System Agronomic Software / Farm Management Tools
AgEagle Aerial Systems Inc.	United States	Unmanned Aerial Vehicles (UAVs / Drones) Advanced Imaging & Remote Sensing System Data Analytics & Decision Support System (DSS)
Farmers Edge Inc	Canada	Data Analytics & Agronomic Insights System Satellite Imagery & Remote Sensing System Weather Monitoring & Risk Management Tool
Mothive	United Kingdom	IoT-based smart sensor system Decision support system (DSS) Predictive analytics tool Precision agriculture platform
CropX	Israel	Cloud-Based Farm Management Software Precision Irrigation Management System

## **2.4 Status of Agriculture in Developing Country**

Agriculture remains a key economic sector in developing countries, supporting nearly 500 million smallholder households and contributing significantly to GDP (Rapsomanikis, 2015). However, production systems are largely traditional, labor-intensive, and dependent on rainfall, making them vulnerable to climate variability such as droughts and floods (Cervantes-Godoy et al., 2013). Farming is often subsistence-oriented, integrating crops and livestock for food security and income stability (Resilience, 2022).

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Table 3 highlights that developing regions dominate global agricultural value added. Asia’s share increased from 63% in 2012 to 65% in 2021, while Africa remained stable at around 11%. In contrast, Europe (9–11%) and Oceania (1–2%) contributed relatively small shares, and the Americas accounted for 13–15%. This indicates that agriculture is heavily concentrated in developing regions, particularly in Asia.

Despite this strong contribution, productivity remains low due to limited technology adoption, weak infrastructure, and poor market access (World Bank, 2022). Although global agricultural value added reached USD 3.7 trillion in 2021 with steady growth (FAO, 2023), the benefits are unevenly distributed. Thus, agriculture in developing countries remains economically important but structurally constrained, highlighting the need for modernization and technological transformation.

**Table 3.** Global agriculture value added by region

Year	Africa	America	Asia	Europe	Oceania
	Percentage (%)				
2012	11	14	63	10	2
2013	11	15	62	10	2
2014	11	14	62	11	2
2015	11	15	62	10	2
2016	11	15	63	10	1
2017	11	14	63	10	2
2018	11	14	63	10	2
2019	11	14	64	10	1
2020	11	14	64	09	2
2021	11	13	65	09	2

### 3. SUBSISTENCE AGRICULTURE VS PRECISION AGRICULTURE

Subsistence agriculture is primarily focused on household survival, with farmers cultivating small plots using traditional methods and minimal inputs (Bisht et al., 2014). Production is mainly for family consumption, decision-making is experience-based, and systems are labor-intensive with low capital investment. As a result, yields are generally low to moderate, and farmers remain highly vulnerable to environmental risks.

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In contrast, precision agriculture is a data-driven system that uses advanced technologies such as GPS, sensors, drones, and data analytics to optimize resource use and improve productivity. Decision-making is based on real-time data, enabling site-specific input application and more efficient farm management.

Table 4 shows clear differences between the two systems. Subsistence farming operates on small-scale landholdings with low input use and limited market orientation, whereas precision agriculture is typically medium to large-scale, capital-intensive, and market-driven. It offers higher productivity, improved risk management, and reduced labor dependency through mechanization.

The table illustrates a shift from traditional, subsistence-based farming to modern, technology-driven agriculture. However, this transition is constrained in developing countries by financial, technical, and institutional barriers.

### **3. CONSTRAINTS TO TRANSFORM SUBSISTENCE AGRICULTURE TO PRECISION AGRICULTURE**

#### **3.1 Constraints as Nation**

At the national level, multiple structural constraints significantly hinder the effective adoption of precision agriculture in developing countries, particularly in relation to economic capacity, trade priorities, and diplomatic positioning. The overall economic status of a nation determines its ability to invest in advanced agricultural technologies, research infrastructure, and farmer support systems; however, many developing countries operate under limited fiscal space, restricting large-scale investment in precision agriculture (Klerkx et al., 2019). As a result, governments often prioritize immediate food security over long-term technological transformation. Furthermore, export and import policies play a critical role in shaping agricultural modernization. Developing countries tend to rely heavily on importing precision agriculture tools, including sensors, software, and improved seeds, which increases production costs and creates dependency on foreign technologies (Daum & Birner, 2020).

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**Table 4.** Difference between subsistence and precision agriculture

Variables	Subsistence agriculture	Precision agriculture
Concept	Is a farming system in which farmers use small plots of land mainly to produce food for their own families (Bisht et al., 2014)	A data-driven farming system that uses advanced technologies to manage field variability and apply inputs precisely based on site-specific needs
Objective	Its primary goal is household survival and self-sufficiency rather than profit, with crop choices based on family needs rather than market demand (Bisht et al., 2014)	Its primary goal is to optimize resource use and maximize productivity while minimizing production costs and environmental impacts, with management decisions based on real-time data rather than uniform practices.
Scale of Operation	Small-scale, limited land holdings	Medium to large-scale, often commercial farms
Technology Use	Minimal, traditional tools and methods	Advanced technologies such as GPS, sensors, drones, and data analytics
Input Use	Low and often based on traditional practices	Optimized, site-specific application of inputs
Productivity/Yield	Low to moderate yield	High yield due to efficient management
Market Orientation	Mainly for household consumption	Market-oriented and profit-driven
Decision-Making	Based on experience and tradition	Based on data and real-time information
Labor Requirement	Labor-intensive, relies on family labor	Less labor-intensive, more mechanized
Capital Requirement	Low investment	High initial investment
Risk Management	High vulnerability to environmental changes	Improved risk management through monitoring and forecasting

At the same time, their agricultural exports are primarily raw commodities with low value addition, limiting their capacity to capture economic benefits from increased productivity.

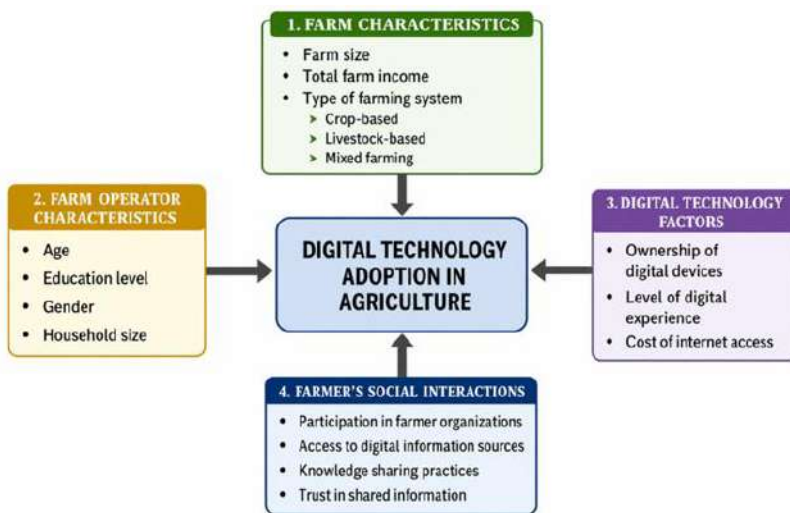
Diplomatic relationships also influence access to technology, funding, and knowledge transfer. Countries with stronger ties to technologically advanced nations may benefit from partnerships, grants, and technical assistance, while others remain marginalized in global innovation networks. However, such collaborations often come with conditions that favor technology providers, reinforcing asymmetrical power relations. Consequently, the interplay of weak economic capacity, unfavorable trade structures, and unequal diplomatic influence constrains the ability of developing nations to fully realize the potential of precision agriculture, ultimately limiting its contribution to sustainable agricultural development.

### **3.2 Constraints as Farmer**

The transition from subsistence to precision agriculture in developing countries is significantly constrained at the farmer level due to interconnected limitations in education, digital literacy, training access, and technology usability. Farmers' education level plays a foundational role, as low formal education restricts their ability to interpret data-driven recommendations and operate advanced tools, a challenge widely reported in developing regions (Aker, 2011; Mittal & Mehar, 2016). This is further compounded by digital literacy barriers, where limited familiarity with smartphones, applications, and internet-based platforms prevents effective utilization of precision technologies (Fabregas et al., 2019). A conceptual framework illustrated in Figure 3 highlights that digital technology adoption in agriculture is shaped by four domains: farm characteristics, farmer demographics, access to digital tools, and social interaction networks. For instance, small farm size, low income, and subsistence-oriented farming systems reduce investment capacity, while farmer characteristics such as age, education, and gender influence openness to innovation. Similarly, lack of ownership of digital devices, low digital experience, and high internet costs further restrict adoption. In addition, weak access to training and extension services limits farmers' ability to acquire necessary skills, as many developing countries face shortages of extension personnel and institutional support (Anderson & Feder, 2007).

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Finally, technology usability issues arise because most precision agriculture tools are designed in developed countries without considering local languages, socio-economic conditions, or smallholder needs, making them difficult to operate and adapt. Social factors such as limited participation in farmer organizations, weak knowledge-sharing networks, and low trust in information sources further reduce technology diffusion. Together, these constraints create a situation where precision agriculture tools, even when available, fail to deliver their intended benefits at the farmer level.



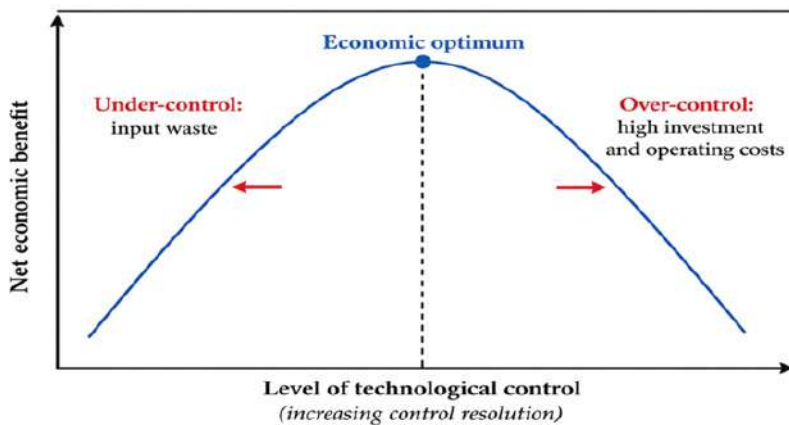
**Figure 3.** Constraints of farmer digital adoption (Source: Uy et al., 2025)

### **3.3 Maintenance, Infrastructure, and Support Limitations**

Precision agriculture in developing countries is significantly constrained by interconnected challenges related to infrastructure gaps, limited technical support, high maintenance costs, and the persistent rural–urban divide. Reliable infrastructure, particularly electricity and internet connectivity, is fundamental for operating data-driven agricultural tools; however, many rural regions lack consistent access to these services, restricting real-time data usage and decision-making capabilities. According to the International Telecommunication Union, a substantial proportion of rural populations in developing countries remain disconnected from digital networks, thereby limiting the functionality of precision technologies (Canton, 2021).

Furthermore, the availability of technical support services is often inadequate, as trained personnel and repair facilities are concentrated in urban centers, leaving farmers in remote areas dependent on external or delayed assistance (Klerkx et al., 2019).

The figure 4 below shows that economic returns depend strongly on the level of technology control. Lower control is associated with weak or negative returns, while higher control improves profitability, indicating that limited technical capacity and reliance on external support reduce the effectiveness of adoption.



**Figure 4.** Effect of technology control on net economic benefit (Source : Kovács & Szöllősi, 2026)

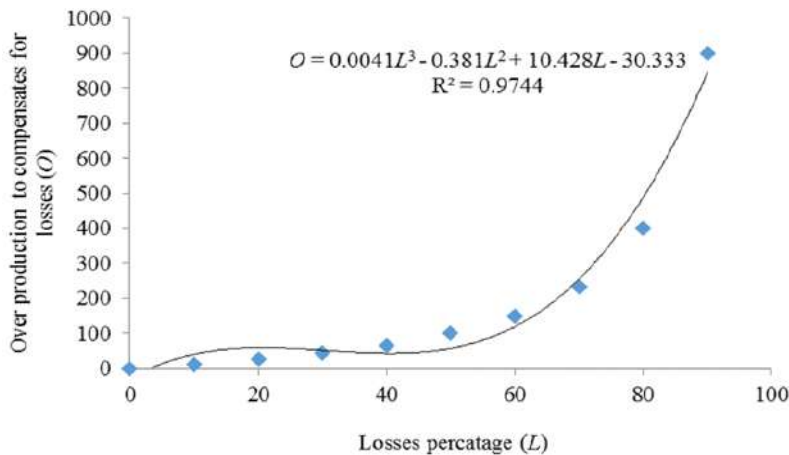
Maintenance costs further constrain adoption, as technologies require regular updates, calibration, and imported components, increasing financial pressure on smallholders (Lowenberg-DeBoer & Erickson, 2019). The rural–urban divide reinforces these constraints, with rural farmers facing poorer access to infrastructure and services. Together, weak infrastructure, limited support, high costs, and low technological control reduce both adoption and economic viability.

### **3.4 Market Dynamics and Price Instability**

The adoption of precision agriculture technologies has significantly increased agricultural productivity; however, this improvement often leads to unintended market consequences in developing countries. As farmers implement yield-enhancing tools, overall production rises simultaneously across regions, creating a supply surge that exceeds market demand. According to the Food and Agriculture Organization, such synchronized increases in output frequently result in oversupply, which places downward pressure on market prices, particularly in economies lacking strong price stabilization mechanisms (Montuori, 2018). This demand–supply imbalance is further exacerbated by weak market integration and limited access to global markets, forcing farmers to rely on local markets where price elasticity is low. Consequently, even though production increases, farmers often experience reduced income, highlighting a critical paradox of precision agriculture. Price volatility also becomes more pronounced due to inadequate storage facilities and poor logistics, compelling farmers to sell immediately after harvest when prices are at their lowest. Moreover, the absence of coordinated production planning and market intelligence systems prevents farmers from aligning output with demand trends. Studies indicate that in many developing countries, increased production of staple crops such as rice and maize has been associated with declining farm-gate prices, reducing profitability despite higher yields (Birthal et al., 2015). This situation discourages continued investment in advanced technologies and may lead to financial distress among smallholder farmers. Therefore, without parallel development in market infrastructure, price regulation policies, and value chain integration, the benefits of precision agriculture remain economically constrained, reinforcing income instability rather than improving livelihoods.

The figure 5 below indicates that higher post-harvest losses require disproportionately greater overproduction to offset them. This intensifies oversupply, reinforcing price declines and reducing income gains from increased productivity.

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**Figure 5.** The relationship between the amounts of the overproduction required to compensate for different levels of losses. (Source: Shahbazi et al., 2025)

As a result, higher production does not translate into higher income. Poor storage and logistics force farmers to sell immediately after harvest at low prices, while weak market information systems limit production planning. Evidence shows that increased output of staple crops often leads to lower farm-gate prices, reducing profitability (BIRTHAL et al., 2015). Without improvements in market infrastructure, coordination, and loss reduction, precision agriculture may deepen price instability rather than improve livelihoods.

**4.4 Lack of Value Addition and Agro-Processing**

The lack of value addition and agro-processing remains a critical constraint in realizing the full benefits of precision agriculture in developing countries, particularly through its impact on post-harvest losses, limited processing industries, storage constraints, and market access issues. Despite increased production enabled by precision agriculture, a significant proportion of agricultural output is lost after harvest due to inadequate handling, transportation, and preservation systems; the Food and Agriculture Organization estimates that nearly one-third of food produced globally is lost or wasted, with a disproportionately higher share occurring in developing regions (FAO, 2019).

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This situation is further exacerbated by the limited presence of agro-processing industries, which restricts the transformation of raw agricultural products into higher-value goods, thereby reducing farmers' income potential and increasing vulnerability to price fluctuations (Kumar & Kalita, 2017). In addition, insufficient storage facilities, including cold chains and warehousing infrastructure, force farmers to sell their produce immediately after harvest when market supply is high, leading to lower prices and income instability. The absence of efficient storage systems not only contributes to quantitative losses but also affects product quality, further diminishing market value. Moreover, weak market access, characterized by poor transportation networks, lack of market information systems, and limited integration into formal supply chains, restricts farmers' ability to reach profitable markets. As a result, even when precision agriculture enhances productivity, the absence of supporting value chain mechanisms transforms surplus production into an economic burden rather than an opportunity. Therefore, without substantial investment in agro-processing, storage infrastructure, and market development, the potential economic gains from precision agriculture in developing countries will remain largely unrealized.

#### **4.5 Structural Inequality in Global Agricultural Systems**

Structural inequality in global agricultural systems remains a critical barrier to the equitable realization of precision agriculture benefits, particularly for developing countries. Within the global value chain distribution, developed countries dominate high-value segments such as technology innovation, data analytics, and agro-processing, while developing nations largely remain suppliers of raw agricultural commodities with limited value addition (Gereffi et al., 2005). The role of developed countries is further reinforced through their control over intellectual property, advanced research systems, and multinational agribusiness corporations, which shape global production and trade patterns to their advantage. This imbalance contributes directly to trade inequality, where developing countries export low-value primary products and import high-cost technological inputs, including precision agriculture tools, thereby creating a persistent negative trade balance (UNCTAD, 2025).

Moreover, value capture disparity is evident in the disproportionate distribution of profits along the agricultural value chain; farmers in developing countries receive only a small share of the final market value, while intermediaries, processors, and technology providers capture the majority (OECD, 2020). The integration of precision agriculture, rather than correcting these disparities, may unintentionally reinforce them by increasing dependency on external technologies and limiting local innovation capacity. As a result, the global agricultural system continues to operate in a manner that benefits technologically advanced economies while marginalizing smallholder farmers in developing regions, ultimately restricting their ability to achieve sustainable economic growth and resilience.

## **5. POSSIBLE PATHWAYS FORWARD**

### **5.1 Capacity Building**

A critical pathway toward realizing the benefits of precision agriculture in developing countries lies in strengthening human capital through targeted capacity building. The effectiveness of advanced agricultural technologies depends not only on their availability but also on the ability of farmers to understand and utilize them efficiently. In many developing countries, limited education and low digital literacy significantly constrain adoption. Therefore, investment in farmer education, vocational training, and extension services is essential. Strengthening agricultural extension systems can bridge the knowledge gap by providing hands-on training, demonstration farms, and localized advisory services. According to the Food and Agriculture Organization, participatory training approaches that involve farmers in practical learning processes significantly improve technology adoption rates. Moreover, digital training platforms and mobile-based advisory services can play a transformative role in disseminating knowledge at scale, especially in remote rural areas. The World Bank emphasizes that improving digital skills among rural populations enhances not only agricultural productivity but also broader economic inclusion. Additionally, partnerships between governments, universities, and private sector actors can help develop context-specific training programs that align with local agricultural practices.

Without such capacity-building initiatives, precision agriculture technologies risk remaining underutilized, thereby limiting their potential to improve productivity and farmer livelihoods.

## **5.2 Agro-Industry Development**

The development of agro-industries and value addition systems is another essential strategy for ensuring that increased agricultural productivity translates into higher farmer income. In many developing countries, agricultural systems are primarily focused on raw commodity production, with limited processing and storage infrastructure. As a result, surplus production generated through precision agriculture often leads to price declines rather than increased profitability. Establishing agro-processing industries, cold storage facilities, and efficient supply chains can help absorb excess production and stabilize market prices. According to the Food and Agriculture Organization, value addition through processing can increase farmers' income by up to 30–50% in certain sectors. Furthermore, the International Food Policy Research Institute highlights that strengthening agro-industrial linkages creates employment opportunities, reduces post-harvest losses, and enhances food security. Governments can play a key role by providing incentives for private investment in agro-processing, developing rural infrastructure, and supporting cooperative models that enable smallholder farmers to participate in value chains. In addition, promoting export-oriented agro-industries can help developing countries capture greater value in global markets. Without such structural improvements, the benefits of precision agriculture will remain limited, as increased production alone does not guarantee economic sustainability.

## **5.3 Digital Inclusion**

Digital inclusion is fundamental to bridging the gap between advanced agricultural technologies and smallholder farmers. Precision agriculture relies heavily on digital tools such as sensors, mobile applications, and data analytics platforms. However, unequal access to digital infrastructure and services remains a major barrier in developing countries.

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Expanding rural internet connectivity, improving access to affordable smartphones, and developing user-friendly applications in local languages are critical steps toward inclusive adoption. The International Telecommunication Union reports that rural connectivity gaps significantly hinder the uptake of digital technologies in agriculture. Addressing these gaps requires coordinated efforts from governments, telecommunications providers, and development organizations. Furthermore, designing technologies that are simple, affordable, and tailored to the needs of smallholder farmers can significantly enhance usability. The World Bank suggests that digital platforms offering weather forecasts, market information, and advisory services can improve decision-making and reduce risks for farmers. In addition, open-source digital tools and community-based data systems can reduce dependency on expensive proprietary technologies developed in advanced economies. Ensuring digital inclusion is therefore not only a technological challenge but also a socio-economic necessity for achieving equitable agricultural development.

#### **5.4 Sustainable Innovation**

Sustainable and locally adapted innovation is essential for overcoming the structural limitations associated with precision agriculture in developing countries. Most existing technologies are designed for large-scale, capital-intensive farming systems in developed countries, making them unsuitable for smallholder contexts. Therefore, promoting research and development of low-cost, locally relevant technologies is crucial. National agricultural research institutions, in collaboration with universities and local entrepreneurs, can play a key role in developing context-specific solutions. According to the Consultative Group on International Agricultural Research, locally driven innovation systems are more effective in addressing the unique challenges faced by smallholder farmers. In addition, adopting sustainable practices such as climate-smart agriculture, resource-efficient irrigation, and integrated pest management can enhance resilience while reducing environmental impacts. Public-private partnerships can further support innovation by combining financial resources, technical expertise, and market access. Moreover, policies that encourage open innovation, knowledge sharing, and technology transfer can help reduce dependency on foreign technologies and promote self-reliance.

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Ultimately, sustainable innovation should focus not only on increasing productivity but also on ensuring environmental sustainability, economic viability, and social inclusiveness. Without such a holistic approach, precision agriculture may fail to deliver long-term benefits in developing country contexts.

### **5.5 Easy Global Market Access**

Facilitating easy access to global markets is a crucial pathway for maximizing the economic benefits of precision agriculture in developing countries. Although precision farming enhances productivity, its full value cannot be realized without efficient market integration. Developing digital trade platforms, improving export logistics, and reducing trade barriers can enable farmers to access international markets and secure better prices. Advanced systems such as e-commerce platforms and traceability technologies can improve transparency, ensure product quality, and build consumer trust in global supply chains. Moreover, compliance with international standards and certification systems can significantly enhance competitiveness. Governments and development organizations should support farmers through export facilitation programs, market intelligence services, and infrastructure development, including cold chains and transportation networks. Strengthening global market access can transform precision agriculture from a productivity-focused approach into a driver of sustainable income growth and economic resilience.

### **CONCLUSION**

Precision agriculture offers significant potential to enhance productivity, efficiency, and sustainability in developing countries; however, its adoption is constrained by economic limitations, weak infrastructure, low digital literacy, and dependence on imported technologies. At the farmer level, limited skills and training hinder effective use, while at the national level, unfavorable trade structures and low investment capacity reinforce technological dependency. Additionally, increased production often leads to market oversupply, price instability, and reduced profitability due to weak value chains, inadequate storage, and limited agro-processing capacity.

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Structural inequalities in global agricultural systems further restrict value capture by developing nations. Therefore, realizing the full benefits of precision agriculture requires a holistic approach that integrates capacity building, digital inclusion, infrastructure development, market strengthening, and locally adapted innovations. Without such coordinated efforts, the potential of precision agriculture to drive sustainable and inclusive agricultural transformation will remain largely unrealized.

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**CHAPTER 2**  
**FOREST GOVERNANCE AND RURAL  
LIVELIHOODS IN NIGERIA: UNDERSTANDING  
POWER, PARTICIPATION, AND SUSTAINABILITY**

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## **INTRODUCTION**

Forest governance is pivotal to discussions of natural resource management and rural development in Nigeria. Forest governance is not only about managing forest resources but also about how decisions are made, who makes them, and whose interests are protected. This section explores the definition of governance and what the concept entails. Governance has multiple meanings and is difficult to define. For instance, Fasona et al. (2019) investigated a collaborative forest governance arrangement in southwest Nigeria. They defined forest governance as the "rules, processes, and structures" that govern or guide decisions about using and managing forest resources (p. 77). Governance encompasses "statutory, legal, policy and traditional institutions and framework involved in resource management" (p.77). In this study, the expectations for forest governance were not realised, as existing forest policies were ineffective at reducing deforestation and improving natural resource conservation. However, in simple terms, governance refers to the systems, rules, and institutions that guide how resources are used and controlled. In the context of forests, governance encompasses government policies, community practices, and the roles of private organisations and civil society. Recent studies show that effective forest governance is key to achieving sustainable resource use and improving rural livelihoods (Food and Agriculture Organisation, 2021; World Bank, 2022).

Over time, forest governance has shifted from a purely state-controlled system to more inclusive approaches that recognise the role of local communities (Ayogu, 2023). Earlier systems were largely top-down, with the government controlling access to forest resources and providing little or no input from rural people. While this approach helped to establish forest reserves and regulate timber exploitation, it often ignored local knowledge and excluded forest-dependent communities.

Evidence from Nigeria shows that such exclusion has contributed to conflicts, illegal resource use, and weak conservation outcomes (Andersson et al., 2021; Larson et al., 2021). For instance, Ayogu (2023) noted that in most Nigerian forest reserves, the prevailing governance arrangement effectively increases the State government's revenue generation at the expense of inclusive forest governance.

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The study also noted that community forest resource users and community members in the study areas have never participated in forest governance activities. The forest governance arrangement in the study area is characterised by a lack of empowerment and incentives for the community to support alternative livelihoods (Fasona et al., 2019).

In response to these challenges, there has been a growing call for participatory and decentralised governance systems. These approaches aim to involve local communities in decision-making and give them a sense of ownership over forest resources. Studies have shown that when communities are involved, there is a higher chance of sustainable forest management and better livelihood outcomes (Ribot, 2020; Sunderlin et al., 2021). However, in practice, participation is often limited (Ayogu, 2023). In many cases, power remains with the State, while communities are expected to comply with policies that affect their livelihoods (Ayogu, 2023).

Moreover, Carney, (2003) reviewed contemporary perspectives and experiences on sustainability from diverse sources to better understand the sustainable livelihood (SL) perspectives. The study links the livelihood perspective with governance. She viewed governance as a subset of the broader Policies, Institutions, and Processes (PIPs). Her study defined governance as the way the State's institutions, rules, and systems operate at the central and local levels and shape power relations. The study noted that governance could be carried out by the State, the private sector, and non-governmental organisations to achieve specific purposes, such as improving livelihoods. (Carney, 2003) reiterates that governance encompasses state authority, expenditures, regulations, structures, and decision-making processes.

Brockhaus et al. (2012) conducted a comparative analysis to examine the effects of governance variables on adaptive capacity in forest commons across different levels (national, district, municipal, and community in Burkina Faso and Mali). The governance variables studied included resilience and vulnerability. They defined governance as the structures and processes by which societies share power and shape individual and collective actions. Governance entails formulating, financing, and implementing processes, rules, and strategies at multiple levels between actors, networks, and institutions.

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The study revealed decentralisation as an interesting governance variable enabling adaptive capacities in forest commons governance. Decentralisation facilitated engagement with civil society, enhancing the exploration of new information networks. The authors noted that decentralisation refined actors' roles, triggering learning at the governance level. Finally, they noted that decentralisation triggers divergent strategic responses on governance and adaptive capacities at different levels by breaching the "hierarchical one-way information flow" to achieve effective inter-linkages and relations among forest actors at various levels (Brockhaus et al., 2012, p. 228).

Arts (2014, p. 19) theoretically assessed the emergence of the concept of forest governance through a three-step perspective he called "Triple G" (government, governance, and governmentality). First, he noted that the inadequacies of forest government (state forestry management based on laws) led to the emergence of forest governance. The state government's inadequacies included overexploitation, policy failures, and corruption. He defines forest governance as "new modes of governing that go beyond the confines of the state" (Arts 2014, p. 18). The third G stands for governmentality, which was used to criticise some basic claims of forest governance, including a paradigm shift in the role of the State in forest politics to society. Governmentality refers to the public policy strategies or tools the state leverages to enable grassroots self-governance while simultaneously maintaining central control over forests to address locally "wicked" or unresolved policy problems (Arts, 2014).

Arts (2014, p. 19) reviewed "good governance" as an advocacy to reform the public sector based on certain normative principles, including participation, equity, accountability, transparency, and cost-effectiveness. The concept of good governance can be applied in forestry as advocated by the Food and Agriculture Organisation (FAO). The good governance concept is crucial in achieving forest sustainability as it promotes transparency, equity, and inclusiveness in forest governance.

Forms of good forest governance include Participatory Forest management (PFM), decentralisation, certification of forest lands and resources, and payment for ecosystem services (PES). The PFM and decentralisation are of interest to this thesis.

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The main objective of the PFM is to achieve sustainable forest management through community governance, alone or in partnership with state forest departments, rather than sole governance by the State. There is usually a sustainable forest governance outcome when the community manages its forest in partnership with other civil groups or state departments, because people are granted ownership and responsibility for the resources (Arts, 2014).

Decentralisation is the movement of political authority from the central State to the subnational administrations (Arts, 2014). Some benefits of decentralisation include increased policy effectiveness, greater political participation, and enhanced political accountability at the regional and community levels. Unfortunately, decentralisation has not been fully implemented in Nigeria, despite significant advocacy for its implementation (Enuoh & Ogogo, 2018).

Another important development in forest governance is the emergence of multi-actor systems. Governance is no longer the sole responsibility of the government. Private companies, non-governmental organisations, and international bodies now play active roles in shaping policies and practices. Initiatives such as REDD+ have further expanded the governance space by introducing market-based approaches to forest conservation. While these efforts aim to reduce deforestation and promote sustainability, they have also raised concerns about equity, transparency, and the actual transfer of power to local communities (Angelsen et al., 2020; Duchelle et al., 2021).

In Nigeria, the situation reflects many of these global trends but also presents unique challenges. Forest governance systems, especially in areas like Cross River State, are still largely characterised by centralised control and limited community involvement. Policies are often designed without adequate consultation, and enforcement measures sometimes restrict local access to forest resources without providing alternative livelihoods. This inadequacy has created tension between conservation goals and the survival needs of rural households (Ayogu, 2023)

Despite these challenges, there is increasing recognition that sustainable forest management cannot be achieved without the active involvement of local people. (Ayogu, 2023) Forest-dependent communities possess valuable knowledge and have a direct stake in the long-term health of forest ecosystems.

Strengthening their participation, improving transparency, and ensuring fair distribution of benefits are critical steps toward better governance outcomes (Ayogu, 2023).

The Triple G

" (government, governance, and governmentality) concept of forest governance perspective by Arts, (2014)

## **1. GOVERNMENT/ STATE FORESTRY**

Forests were regarded as "public goods" that served society's interests in the past (Arts, 2014, p. 17). National forest laws were introduced after industrialisation in the 19th century to curtail the rapid rate of deforestation and degradation of forest resources (Arts, 2014). These laws were formulated to reduce degradation and control forest ownership and forest-related controversies. It also increases the State's revenue through tree concession logging and taxation. In this era, the State applied these forest laws to govern forests through scientific forestry, including sustained-yield principles and silvicultural methods. Most forests were owned by the State, with a few private forest ownerships in some countries. The abundance of State-owned forests was due to the removal of the rural community's traditional "forest commons" with their customary rights and responsibilities by modernisation, often by force (Arts, 2014, p. 18). The state-owned forests were controlled and managed by the government. For instance, the government determined silvicultural practices and logging consensus on these forests.

This paradigm achieved successes, such as increased timber production and employment, because it was built on scientific forestry practices. But it failed to address forests' ecological and social issues, leading to changes in sustainability principles. This system of state forestry and policy was introduced in other countries outside Europe, leading to the creation of forest reserves. Forest reserves were created, especially where highly dense forests were declared state-owned property (Arts, 2014). The state forestry paradigm generally opposes the rural community and social initiatives and is characterised by the following:

- Exclusion of rural people from their indigenous land inheritances and the suppression of traditional forest institutions,

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- Unsustainable exploitation of forest resources is always at odds with the needs of rural communities and conservation initiatives.
- Increased tree logging concessionaire to private and public companies,
- Promoting corruption practices in the timber forest value chain; and
- Playing an absent manager role in rural areas is fuelling illegal use.

These shortfalls have led many countries to reform public forest policies and laws through forest governance, focusing more on "decentralisation, community involvement in forest governance" through commercialisation (Arts, 2014, p. 18).

## **2. FOREST GOVERNANCE**

Some researchers believe forest governance is a new mode of governance above state authority and see it as a shift from state government to the authority and competencies of other institutions, such as international Organisations, NGOs, and communities (Arts, 2014). However, a broader conceptualisation of governance emerged in the literature, viewing it as simply "governing by, governing with or without the state" (Arts, 2014, p. 19). It could involve the government and new governance modes, such as network-like arrangements and public-private partnerships. According to Arts (2014), governance can be achieved through forcing others (strict governance), persuading or sharing resources with others to achieve outcomes (broad governance), or a combination of the two, in line with public policy objectives. Thus, the State is still part of the governance process, but its role and function are no longer as a commander or controller, issuing authority from top to bottom. Rather, they are equal partners with the community or private groups in the new governance arrangements.

Forest governance advocates for power devolution among the government, civil society, and rural forest user groups. It promotes a governance approach in which diverse forest stakeholders jointly implement forest decision-making and forest management. According to Arts (2014), this new forest governance paradigm promotes the rights and participation of rural communities in forest decision-making processes, though it is only sometimes successful.

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REDD+ is a forest management approach that emphasises the provision of new forest governance services without the State's interference (Arts, 2014). REDD+ refers to reducing emissions from deforestation and forest degradation. REDD+ operates under market governance without the State, with its main aim to facilitate self-governing markets for trading ecosystem service credits. However, REDD+ was designed to hollow out or relocate the government's power and authority from national or international to subnational or Private Organisations (Sunderlin et al., 2017). Yet the State remains present in REDD+ services. For instance, in the CRNP and other forest reserves in Cross River State, REDD+ was introduced to decentralise forest governance, with or without the State, to include local communities, local forest departments, or both (Arts, 2014; UN-REDD Cross River State, 2017).

Forest governmentality: Some scholars have observed that the State has transferred little "real" governance authority and decision-making power to rural communities (Arts, 2014, p. 20). An example is in Cross River State, where the government's presence is strongly felt in REDD+, which strengthens state management of forestry rather than a participatory governance approach. Arts (2014) noted that governmentality is a theoretical notion that could address the imbalance between the State's societal control and the "diffusion of power in the society" (p. 20). In this concept, the government does not rule the people directly; instead, it creates strategies that enable people to become responsible citizens by allowing them to govern themselves. The State, through this strategy, executes their difficult and unresolved policies through the people.

Arts (2014) noted that governance reform involves maintaining control differently, rather than transferring meaningful authority to lower administrative tiers or communities. He noted that, in practical terms, governance and administrative reforms mean the State transferring or decentralising unresolved policy and financial problems to communities, while maintaining valuable control over assets and resources. This action reaffirms power relations and structures rather than bringing about change. In another approach, the states and NGOs focus on people who have taken on responsibility for protecting the environment and forest-related identities. For example, in the authoritarian forest governance approach, conservationists see rural people as despoilers of forest resources and as backward.

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Therefore, they are excluded from their forestlands. But under the new forest governance arrangements, rural people's identity has shifted to that of the "noble savage and guardians of the forests" (Arts, 2014, p. 21) to enable them to manage their forests in ways the state values.

Meanwhile, these new forest governance arrangements are rarely operational in the study area. As a result, there is no complete transfer of discretionary power to rural people in the few locations where it is practised in Cross River State. Instead, the government maintains central power and utilises the situation to implement challenging public policy. Nor are these new forest governance arrangements practised in the Enugu forest communities. Therefore, this thesis will pursue other forms of forest governance than the governmentality approach. Instead, it will focus on Nigeria's predominant forest governance approaches, state-controlled and community forestry. These existing forest governance approaches are important to this thesis.

Including forest-fringe communities has many benefits for achieving sustainable forest management. Even if their inclusion does not increase their decision-making power, reorienting rural people towards the future of their forests will increase their knowledge, boosting their human capital in sustainable forest management. As their knowledge grows, they will understand their rights and begin contributing positively to the decision-making process. Therefore, this thesis supports the inclusion of rural communities in forest governance.

To sum up, this section of the book chapter defines forest governance as the rules, the range of institutions (statutory, legal, policy, and customary), and the framework that shape forest decision-making regarding the use and control of natural resources, whether that process is autocratic or egalitarian. This chapter, therefore, examines forest governance in Nigeria, focusing on the balance between conservation and rural livelihoods. It explores how the top-down governance approaches shape access to forest resources, influence power relations, and affect sustainability outcomes. Drawing on literature and practical experience, the chapter highlights the need for more inclusive, participatory, and context-specific governance systems that support both environmental conservation and human well-being.

### ***The Top-Down Forest Governance Structures and Approach***

This section provides background for discussing the governance approaches employed in Cross River National Park (CRNP). Discussing the forest institutions' governance approach would help expose the forest governance that prevents or enhances the balancing of forest conservation and people's livelihoods. Therefore, this section discusses the forest institutions' governance approaches to demonstrate the strengths of each in balancing forest conservation and people's livelihoods.

The top-down forest governance approach denotes the government's presence in state forestry. This approach employs strict law enforcement and rules, along with scientific forestry, to conserve core forest zones and reduce deforestation and degradation. The top-down forest governance approach is conventional (Arts, 2014). It is characterised by the absence of rural people from forest governance, a rigorous registration process for forest livelihood activities, forced relocation of enclave communities, and reduced local access to assets. In the international literature, top-down forest governance is often viewed as an expert-led "quick-fix" solution to complex problems (Raison et al., 2001). However, this governance approach is also viewed with mixed perceptions of success and failure. It is believed that the top-down forest governance approach is the right approach for forest conservation, requiring strict adherence to forest rules (Rodriguez-Ward et al., 2018). But, by all indications, the top-down approach has never fared well in achieving its conservation goals, as it leads to various forms of conflict and stirs negative attitudes among rural people towards forest conservation.

The historical overview of the forest governance approach of the National Park: note that the National Park's governance has been enabled by Ite & Adams (2000) technical and financial assistance from the Worldwide Fund for Nature-UK (WWF-UK), the Nigeria Conservation Foundation (NCF), and the UK Department for International Development. The Park projects have received additional financial benefits from the European Union (EU) under the Lomé IV Convention and from the Kreditanstalt für Wiederaufbau (KfW), a German Development Bank. Moreover, the Wildlife Conservation Society (WCS) is active in conservation (Agaldo et al., 2013; Ite, 1998).

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The Federal Government of Nigeria, the Cross River State Government, and the CRNP fringes communities' households provide governance support (Ite, 1998). One of the fundamental principles underlying the planning and establishment of the CRNP is that conservation and development are complementary and mutually reinforcing. The original planners of the CRNP admit that conservation and development are ultimate and complementary activities because, without development, conservation efforts would be futile. They knew it would be impossible to conserve resources amid hunger, poverty, and underdevelopment. That is why the initial approach to protecting and developing the Park was based on the people-and-conservation governance approach (Ite, 1998).

A central governance team comprising international experts in different aspects of the Park and people-oriented programs was proposed to govern the CRNP, as Nigeria never had a rainforest park. After bureaucratic bottlenecks, funding for the Okwangwo Division of the Park commenced in 1994, while the Oban Division resumed in 1995 (Enuoh & Ogogo, 2018). The WWF managed the Okwangwo program at the take-off, while the European Union governed the Oban program. Still, advocates of authoritarian or strict protection disagreed with the conservation and development approach. Enuoh and Ogogo (2018) note that strict conservationists claim that conservation with a development approach can never achieve the objective of successful biodiversity conservation. The first phase of the CRNP's governance plan consisted of investments in rural infrastructure. The investment in rural livelihood activities and the resettlement of the enclave villages were planned, with 75% of the budgeted funds yet to be expended, when supporters of strict protection, dominant in the biodiversity literature, shifted the policy against people-oriented governance. At this stage, the original plan for the Park, prepared by WWF/ODNRI in 1989, was abandoned. The approach was replaced by a conflict-ridden strategy that sparked attacks between park managers and local people. After strict conservationists took over the Park's governance, the Park's integrity was threatened by illegal hunting and farming by the rural population (Enuoh & Ogogo, 2018).

### ***Historical Overview of Forest Reserve Governance***

This section examines the evolution of the approach, with a particular focus on the Cross River Forest Reserve. The Cross River forests have "a long history of forest use and local governance" (Ite, 1998, p. 142), meaning that before the declaration of the Cross River forests as reserve areas, people had set down rules that guided the harvesting of non-timber and timber resources from the forest. Around 2009, Cross River State became a partner in the reduction of emissions from deforestation and forest degradation (REDD+). The State's becoming a REDD+ partner led to communities being banned from accessing forest resources to support livelihoods. According to Ekott (2016), the government did not adequately communicate with the communities before the ban. Some community members perceived that the government was reserving forests without community participation or creating livelihood alternatives for impoverished forest-dependent communities that have conserved the forests for years.

The initial governance of the forest reserves before the ban required that, before harvesting any tree, a forest official certify the tree's maturity, plant five seedlings in its place, and pay a monetary royalty to the community. Community members depend on forests for their food security and livelihoods, and now lament the violation of people's rights and the deprivation of livelihood resources. Despite forest reservations being designated as protected areas, many forest areas still do not receive absolute protection due to challenges to TMF conservation rooted in Nigeria's socio-economic and political spheres of governance (Ite, 1998). The next section discusses the top-down forest governance structure in Nigeria.

### **CONCLUSION**

This chapter has shown that forest governance in Nigeria is not just about managing trees and protected areas. It is about power, participation, and how decisions affect the daily lives of rural people. The evidence presented makes it clear that governance systems shape who benefits from forest resources and who bears the cost of conservation (Raison et al., 2002). The long-standing top-down approach has played a role in the creation of forest reserves and in the control of exploitation (Ayogu, 2023).

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However, it has also excluded local communities and weakened their connection to the forests they depend on. Recent studies confirm that exclusion often leads to conflict, illegal resource use, and poor conservation outcomes (Andersson et al., 2021; Larson et al., 2021). In many parts of Nigeria, including Cross River State, policies still limit access to forest resources without providing real alternatives for livelihoods. This situation continues to create tension between conservation goals and survival needs.

There is now stronger agreement in the literature that inclusive governance works better. When communities are involved in decision-making, they are more likely to support conservation efforts and manage resources responsibly. For example, the Food and Agriculture Organisation (2021) and World Bank (2022) both highlight participation, transparency, and accountability as key to sustainable forest management. More recent work also shows that community-based and co-management approaches can improve both forest outcomes and rural incomes when they are properly implemented (Sunderlin et al., 2021; Duchelle et al., 2021).

Even so, the chapter also shows that participation in Nigeria is often more on paper than in practice. Power still sits largely with the State (Ayogu, 2023). Decentralisation has not gone far enough, and many reforms do not transfer real authority to local people. Instead, communities are sometimes given responsibilities without the power or resources to act. This gap between policy and reality remains a major challenge (Ribot, 2020).

Another key point is that forest governance cannot be separated from livelihoods. Rural households depend on forests for food, income, and cultural identity. Any policy that restricts access without support for alternative livelihoods is likely to fail. Recent studies emphasise that linking conservation with livelihood improvement is essential for long-term success (Ikueomonisan, 2024; World Bank, 2022). This linkage means that governance systems must go beyond protection and include strategies that support local economies (Ayogu, 2023).

Conclusively, improving forest governance in Nigeria will require stronger institutions, clear policies, and real commitment to participation. It will also require investment in rural livelihoods so that conservation does not come at the expense of the poor.

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When governance is fair and inclusive, forests are more likely to be protected, and communities can thrive. Finally, sustainable forest management is not only a technical issue. It is a social and political one. Getting governance right is therefore central to achieving both environmental sustainability and rural development in Nigeria.

This chapter, therefore, recommends that government forest institutions in Nigeria move from control-based governance to more balanced, people-centred systems. These systems include giving communities a stronger voice, improving accountability, and building trust among stakeholders. It also means recognising local knowledge and creating space for shared decision-making. Multi-actor approaches involving government, NGOs, and the private sector can help, but only if they are well coordinated and genuinely inclusive.

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**CHAPTER 3**  
**EVALUATE THE EFFECTS OF AGRICULTURAL  
EXTENSION PROGRAMME (IFAD-VCDP) ON  
INCOME GENERATION ACTIVITIES AMONG  
CASSAVA FARMERS IN GBAKO LGA OF NIGER  
STATE, NIGERIA**

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## **INTRODUCTION**

Cassava (*manihot esculenta crantz*) is a tuber crop, a non-inbred crop and propagated colonially (Adawo, 2021). It is one of the few staple crops that can be produced efficiently on a small scale, without inputs, and in marginal areas with poor soils and unpredictable rainfall (Akani, 2025). Its genetic improvement a superior genotype to be fixed at any stage of the breeding scheme, even after a single cross. Cassava species originated on the southern edge of the Brazilian Amazo, cassava (*Manihot esculenta Crantz*) is one of some 100 species of trees, shrubs and herbs of the genus *Manihot*, which is distributed in northern Argentina (Ahmadu, 2025). Cassava (*manihot esculenta*) is widely cultivated in Nigeria where it plays vital role in the food security of the rural economy because of its capacity to yield under marginal soil condition and it's tolerant of drought (Ayodele, 2024). Agriculture remains a critical sector in the economy of Nigeria, employing a significant proportion of the rural population and contributing substantially to food security, income generation, and rural development. Among the various crops cultivated, cassava plays a vital role due to its adaptability to diverse agro-ecological conditions, resilience to climate variability, and importance as both a food and industrial crop. Cassava production provides livelihoods for millions of smallholder farmers, particularly in rural communities such as Gbako Local Government Area in Niger State (Ahmadu, 2025). Despite its importance, cassava production in Nigeria is often characterized by low productivity, limited access to improved inputs, poor processing techniques, and weak market linkages. These challenges constrain farmers' income generation potential and overall economic well-being. In response, agricultural extension programmes have been introduced to bridge the gap between research innovations and farmers' practices, with the aim of improving productivity, enhancing value addition, and increasing rural incomes. Researchers affirmed that cassava's comparative production advantage over other staple crops in Nigeria serves to encourage its cultivation even by the resource poor farmers (Bamidele, 2025).

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The principal strategy of Nigerian government is to promote agricultural development programmes aimed at increasing food production particularly in the rural areas in order to improve food self-sufficiency while generating income through processing and marketing of surplus products to reduce poverty (Ayodele, 2024). The National Special Programme for Food Security (NSPFS) is one of such programmes aimed at reducing food insecurity. NSPFS came as a result of Nigeria participating in the World Food Summit of November 2004 (Cheka, 2024). As one of the Low Income Food Deficit Countries (LIFDCS), she requested for assistance under the United Nations' (UN) Food and Agricultural Organisations' (FAO) Special Programme on Food Security (SPFS). A tripartite participatory review of beneficiary communities was held in Nigeria which resulted to a pilot phase of the Special Programme on Food Security (SPFS) being conducted in Kano state in 2005 (zakari, 2024). In 2005, following the successful completion of the pilot phase in Kano, the SPFS was further up- scaled over a five year period from 2005 to 2010 nationwide National Special Programme on Food Security (NSPFS) covering the thirty six (36) states with 109 sites (communities) across the country with a total programme cost of USD 75.4 million (Bashir and Yohana, 2025). The mandate of NSPFS is to assist farmers in increasing output and productivity and consequently income on sustainable basis, strengthen the effectiveness of research and extension services in bridging technology and new farming practices developed by research institute (Dange, 2025). The targeted crops and livestock are cassava, rice, cocoyam, yam, leafy vegetables, poultry, and sheep, goats and swine production. The main strategy of NSPFS is to empower small farming communities with provision of soft loan, agricultural inputs and technical support services to achieving NSPFS objectives of increasing farmers output and income on a sustainable basis (Damilola, 2025). The participatory farmers are formed into groups for ease of co-ordination and management of credits and inputs received on behalf of farmers (Elija, 2025). In Gbako LGA, where agriculture is the mainstay of the local economy, the implementation of IFAD-VCDP is expected to influence farmers' income generation activities by improving yields, reducing post-harvest losses, and expanding market access.

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However, the extent to which the programme has effectively enhanced income-generating activities among cassava farmers remains an empirical question that requires systematic evaluation (Bashir and Yohana, 2025).

Therefore, this study seeks to evaluate the effects of the IFAD-VCDP agricultural extension programme on income generation activities among cassava farmers in Gbako LGA of Niger State. The findings of this study will provide insights into the effectiveness of extension interventions in improving rural livelihoods and inform policy decisions aimed at strengthening agricultural development programmes in Nigeria.

***Aim and Objectives***

Specifically, the study is aimed at evaluating the Effects of Agricultural Extension Program (IFAD-VCDP) on Poverty Reduction among Cassava Farmers in Gbako LGA of Niger State, Nigeria.

Specific objectives are to:

- describe the socio-economic characteristics of the respondents in the study area.
- examine the effect of IFAD/VCDP on income of the respondents in the study area.
- identify the constraints encountered by the respondents in the study area.

**1. METHODOLOGY**

***Study Area***

This study was conducted in Gbako Local Government Area of Niger State, Nigeria. Gbako LGA is located in the southern part of the state and is widely recognized as one of the important agricultural zones where crop farming serves as the primary livelihood activity of the rural population. The area is characterized by fertile alluvial soils that support the cultivation of staple crops such as cassava, rice, maize, millet, and sorghum. Cassava production in particular has become a dominant farming activity due to its adaptability to varying soil conditions and its importance as both a food and cash crop. Gbako Local Government Area lies approximately between latitudes 8°15'N and 9°00'N and longitudes 6°30'E and 7°15'E. The area shares boundaries with Lavun LGA to the east, Bida LGA to the north.

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The projected population of Gbako LGA was about 206, 503 people as at 2025, with projections indicating steady growth due to natural increase and rural settlement expansion ( National Bureau of Statistics, 2025). The majority of the inhabitants are rural farmers who depend largely on small-scale agriculture for income and household food security. The climate of the study area is typical of the Northern Guinea Savannah ecological zone. The area experiences two distinct seasons: the rainy season and the dry season. The rainy season usually begins in April and lasts until October, with annual rainfall ranging between 1,100 mm and 1,500 mm, which is suitable for cassava cultivation. The dry season extends from November to March and is often characterized by the harmattan wind. Average temperatures range between 25°C and 34°C, creating favorable conditions for crop growth throughout most of the year.

***Sampling Procedure and Sample Size***

A multi-stage sampling procedure was adopted for the study in order to ensure adequate representation of cassava farmers participating in the IFAD-VCDP programme within Katcha LGA. Multi-stage sampling is considered suitable for agricultural extension studies because it allows researchers to systematically select respondents from different administrative and community levels while reducing sampling bias (Mohammed, 2025).

The first stage involved random selection of Agricultural zone of the State followed by purposive selection of Gbako Local Government Area due to the presence of IFAD-VCDP intervention activities focusing on cassava production and value chain development. The third stage involved random selection of four participating communities within the local government area where cassava farmers have been actively involved in the programme. These communities were selected based on the availability of registered cassava farmers and the level of extension programme implementation in those locations. The selected communities were Etsu Audu, Edozgigi, Akote and Benuko. ). At the fourth stage, 10% of the farmers were randomly selected from the sampling frame of each community. In all, a total of 123 respondents were selected from the LGA as the sample size for the study.

**Table 1.** Distribution of Respondents

<b>LGA</b>	<b>Communities</b>	<b>Sampling Frame</b>	<b>Sample Size</b>
<b>Gbako</b>	Etsu Audu	284	28
	Edozhigi	346	35
	Benuko	318	32
	Akote	282	28
<b>Total</b>	<b>4</b>	<b>1,230</b>	<b>123</b>

Source: Niger State Ministry of Agriculture and Rural Development (2025)

## **2. RESULTS AND DISCUSSIONS**

### *Socio-economic Characteristics of Respondents*

The socio-economic characteristics of the respondents under consideration include age, sex, marital status, household size, years of farming experience, level of education.

#### *Age of the Respondents*

Results presented in Table 1 show that the mean age of the respondents in the study area was 43 years. This implies that the majority of the farmers fall within the middle-age category, a group generally considered to be in their most economically active and productive years. Individuals within this age bracket are typically characterized by adequate physical strength, farming experience, and a higher level of mental alertness, which enhances their capacity to understand, evaluate, and adopt improved agricultural practices. This result is consistent with the findings of Majidadi and Yusuf (2024), who reported that the level of acceptance of agricultural extension programmes is closely associated with the age of farmers across different socio-economic systems. They noted that middle-aged farmers, in particular, tend to demonstrate higher levels of participation and adoption of innovations compared to younger or older farmers, thereby contributing more effectively to improved agricultural outcomes and livelihood enhancement.

#### *Marital Status of the Respondents*

Findings presented in Table 2 reveal that 97.0% of the respondents in the study area were married.

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This high proportion suggests that most of the farmers have considerable family responsibilities, which often serve as a strong economic motivation to improve their livelihoods. Married individuals, particularly in rural settings, are more likely to seek stable and sustainable sources of income in order to meet household needs such as food, education, healthcare, and general welfare. As a result, they may be more inclined to participate in agricultural extension programmes that promote reliable and improved crop production practices. The implication of this finding is that marital status can positively influence farmers' commitment to agricultural activities and their willingness to adopt innovations that enhance productivity and income. Married farmers may also benefit from spousal support in farm decision-making and labour contribution, which can further facilitate the adoption and effective utilization of extension services and technologies.

This finding aligns with the report of Garba and Abu (2025), who observed that marital status is a significant socio-economic variable influencing the adoption of new innovations among rural populations in Nigeria. They emphasized that married individuals tend to be more responsive to development interventions due to their greater sense of responsibility and long-term livelihood considerations. Consequently, marital status plays an important role in shaping farmers' attitudes toward agricultural extension programmes and their overall level of participation.

### ***Sex of Respondents***

The results presented in Table 2 indicate that the majority of the respondents (86%) were male, revealing a clear gender imbalance in participation within the study area. This suggests that men dominate involvement in agricultural extension programmes, particularly those related to IFAD–VCDP activities. The predominance of male respondents may be attributed to the physically demanding nature of many agricultural operations, which often require significant labour input and are traditionally perceived as male-oriented tasks in rural communities. Also, socio-cultural norms and values prevalent in many rural areas tend to assign men primary responsibility for farming and decision-making related to agricultural production, while women may be more engaged in supportive or household roles.

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These cultural expectations can limit women's access to extension services, productive resources, and participation in formal agricultural programmes, thereby contributing to the observed disparity.

This finding is consistent with Bello (2025), who reported that men are more actively involved in agricultural programmes and projects than women, largely due to prevailing cultural norms and labour demands in rural communities. Similarly, Odeyemi (2024) emphasized that the gender of the household head significantly determines the outcomes of agricultural projects, particularly in Northern Nigeria, where traditional structures often influence resource control and participation. These studies underscore the need for more gender-inclusive approaches in the design and implementation of agricultural extension programmes to ensure equitable participation and benefits.

***Household Size***

Table 2 further reveals that the mean household size of respondents in the study area was 11 persons. This indicates relatively large household units, which are typical of many rural farming communities. A large household size often implies the availability of family labour, which can be effectively utilized in various farm and off-farm activities promoted through agricultural extension programmes. This availability of labour may reduce the cost of hiring external workers and enhance the capacity of farmers to implement improved practices introduced by extension agents. In addition, large households may positively influence the acceptance and adoption of agricultural innovations. With more household members, there is a greater likelihood of shared knowledge, collective decision-making, and internal support for trying new technologies or practices. Household members may also play complementary roles in production, processing, and marketing activities, thereby strengthening the overall impact of extension interventions on income generation. This finding is in line with Bugaje and Hafsat (2025), who observed that larger household sizes tend to enhance the acceptance of new innovations due to family influence and support systems within rural communities. They emphasized that intra-household dynamics often play a significant role in shaping farmers' decisions to adopt agricultural technologies and participate in development programmes.

### ***Experience In Farming Activities***

In Table 2 the average years of experience in farming activities in the study were between 11 and 20 years respectively, while the mean year of experience for the respondents was 17 years. The fact is that the majority of the respondents in the study area started agricultural extension farming activities long ago, which signifies that most farmers in the study area earn their livelihood through Agricultural extension programme. Experience in farming activities over a long period of time will also go a long way in increasing constraints associated with agricultural extension programme. This finding conforms with that of Ahmed (2025) who stated that majority of farmers in the western part of Nigeria had long year experience in Agricultural extension programme which will go a long way in better their livelihoods.

### ***Educational Level***

Table 2 indicates that 81% of the respondents in the study area had no formal education. This suggests a generally low level of literacy among the farmers, which may have important implications for their participation in and benefits derived from agricultural extension programmes. Education plays a critical role in enhancing farmers' ability to access, interpret, and utilize information related to improved agricultural practices. Farmers with some level of formal education are often better positioned to understand extension messages, keep farm records, adopt modern technologies, and respond effectively to changing agricultural conditions. This finding implies that literate farmers are likely to be more innovative due to their greater exposure to information and improved capacity to process and apply new ideas. In support of this, Kabira (2025) asserts that education is a key determinant influencing the adoption of new innovations, as it enhances farmers' awareness, decision-making ability, and openness to change within agricultural production systems.

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**Table 2.** Distribution of respondents according to socio-economic characteristics

<b>Socio-economic characteristics of respondents</b>	<b>(n=123) Frequency (%)</b>
<b>Age (year)</b>	
<b>≤20</b>	7 (4.0)
<b>21-30</b>	42 (24.3)
<b>31-40</b>	39 (22.5)
<b>41-50</b>	56 (22.4)
<b>51-60</b>	24 (13.9)
<b>&gt;60</b>	5(2.9)
<b>Mean</b>	<b>43</b>
<b>Marital status</b>	
<b>Single</b>	13 (2)
<b>Married</b>	108 (97)
<b>Widow</b>	2 (1.0)
<b>Separated</b>	-
<b>Sex</b>	
<b>Male</b>	111 (86)
<b>Female</b>	12 (14)
<b>Household size (number)</b>	
<b>1-5</b>	54 (42.7)
<b>6-10</b>	61 (45.6)
<b>11-15</b>	4 (6.4)
<b>16-20</b>	2 (3.5)
<b>21-25</b>	1 (0.6)
<b>&gt;25</b>	1 (1.2)
<b>Mean</b>	<b>11</b>
<b>Experience in resources utilisation(years)</b>	
<b>1-10</b>	38 (31.2)
<b>11-20</b>	43 (32.9)
<b>21-30</b>	30 (26.6)
<b>31-40</b>	8 (6.4)
<b>&gt;40</b>	4 (2.9)
<b>Mean</b>	<b>17</b>
<b>Educational level (year)</b>	
<b>No-formal education</b>	81 (44.1)
<b>Primary education</b>	10 (8.1)
<b>Secondary education</b>	14 (20.6)
<b>Tertiary education</b>	12 (19.1)
<b>Adult education</b>	6 (8.1)

Sources: Field survey, 2025

***Examine The Effect Of IFAD/VCDP On Income Generating  
Activities Of The Respondents In The Study***

The results presented in Table 3 reveal that a substantial proportion of the respondents (88.0%) were able to employ additional labourers across their various agricultural enterprises. This outcome can be largely attributed to the increased income generated through their participation in the IFAD–VCDP activities. The programme appears to have improved farmers’ access to capital, inputs, and market opportunities, thereby enabling them to expand their scale of production, processing, and marketing operations. As farm activities intensified and enterprise scope widened, the demand for labour naturally increased, leading to the engagement of more hired workers. The capacity to employ additional labour serves as a strong indicator of economic empowerment and enterprise growth among the respondents. It reflects a positive shift in productivity, output, and overall farm performance. Beyond individual benefits, this development also has broader socio-economic implications, as it contributes to local employment generation and income circulation within rural communities. In this regard, participation in IFAD–VCDP not only enhances farmers’ livelihoods but also supports efforts toward reducing unemployment and underemployment in a developing economy such as Nigeria, where agriculture remains a key driver of rural development.

Furthermore, the findings show notable improvements in the respondents’ standard of living. About 71.5% of the respondents reported that they could conveniently pay their medical bills, indicating improved access to healthcare services and a reduced financial burden associated with health-related expenses. Similarly, 79.8% affirmed that they were able to meet housing-related obligations, including house rent and utility bills, suggesting enhanced housing security and overall financial stability. Collectively, these outcomes underscore the significant impact of the IFAD–VCDP programme on income generation and welfare improvement among cassava farmers. The programme not only strengthens productive capacity but also enhances the ability of beneficiaries to meet essential household needs, thereby contributing to improved quality of life and sustainable rural livelihoods.

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Majority 80.1% of the respondents were able to save for future occurrences, which reflects an improvement in financial literacy, planning, and resilience. In addition, (72.6%) of the respondents indicated that they had purchased motorcycles to enhance mobility, making transportation of goods, produce, and services more efficient. Moreover, 89.6% of the respondents stated that they had benefitted from the IFAD-VCDP's financial support programmes targeting the needy, which enabled them to engage more actively in productive agricultural processing and marketing activities. About (82.3%) of the respondents also acknowledged that they were now able to pay their children's school fees, ensuring continuity in education for their families. The percentage of respondents (67.9%) confirmed they could now purchase household equipment necessary for domestic and productive use, while (70.2%) reported an increase in their annual income. Additionally, (71.7%) of the respondents mentioned they could increase the wages and salaries of their labourers, reflecting a spill over effect of improved income generation. A total of (85.1%) of the respondents also revealed that they now have better access to clean water, which is a basic indicator of improved living standards and public health outcomes. These findings are consistent with the report by Bamidele, (2025) in the study on the "Basements of Value Chain Development Programme (IFAD-VCDP) on the Farmers in Gboko Local Government Area of Benue State", which established that IFAD-VCDP had positively effects on income generating activities. This underscores the crucial role IFAD- VCDP has played in raising the economic and social status of the respondents.

***Constraints Faced By Respondents***

Table 5 presents the major constraints encountered by respondents in the study area, ranging from low levels of education to issues of trust and confidence in the programme. The findings indicate that low level of education, with the highest mean score of 8.32, constituted the most significant constraint to effective participation in the IFAD-VCDP empowerment activities. This suggests that limited literacy and educational exposure among respondents may have hindered their ability to fully understand programme requirements, access relevant information, and effectively utilize the opportunities provided.

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Consequently, this could reduce their level of involvement and the benefits derived from the programme. This finding is consistent with David (2025), who observed that low educational attainment among rural dwellers negatively affects their level of participation in agricultural development programmes.

**Table: 4.** Distribution on effect of IFAD/VCDP on income Generating Activities of the respondents in the study

<b>Variables</b>	<b>(n=123) Freq (%)</b>
Increase in Income Annually	112 (70.2)
Rents	87 (79.8)
Employing of More Laborers	107 (88)
Financial Support for the Needy	147 (89.6)
Increase in Laborer Wages/Salaries	96 (71.7)
Having Savings for Future Occurrence	103 (80.1)
Settlement of medical bills	78 (71.5)
Household equipments	71 (67.9)
Participation in Programmes for Family	108 (61.0)
Planning and resilience	79 (72.6.5)
Access to Clean Water	115 (85.1)
Payment of Children's School Fees	102 (82.3)
Purchase of Household Equipment	72 (40.7)
Payment of Medical Bills	132 (74.6)

Source: Field survey, 2025

The second major constraint identified was the lack of counterpart contributions, with a mean value of 6.71. This challenge was largely attributed to delays by the government in fulfilling its financial obligations to the programme. Such delays can disrupt programme implementation timelines, particularly in the disbursement of funds to beneficiaries, thereby slowing down project take-off and reducing farmers' confidence in the programme's effectiveness. The implication is that even when farmers are willing to participate, institutional and administrative bottlenecks may limit their level of engagement and the overall success of the intervention. This finding corroborates Mohammed (2025), who reported that delays in counterpart funding significantly affect farmers' participation and the smooth execution of agricultural programmes.

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Furthermore, lack of trust and confidence in the programme was identified as the least severe constraint, with a mean score of 4.63. Although relatively lower compared to other constraints, it still remains an important factor influencing participation. This issue may stem from previous negative experiences with similar interventions, where promises were not fulfilled or expected benefits were not realized. Such experiences can shape farmers' perceptions and reduce their willingness to fully commit to new programmes. In line with this, Mohammed (2025) also noted that distrust among rural farmers toward agricultural programmes is often rooted in past disappointments, which can adversely affect their level of participation.

Overall, the findings highlight that both individual factors (such as education) and institutional challenges (such as delayed funding and trust issues) play significant roles in shaping farmers' participation in IFAD–VCDP activities. Addressing these constraints through adult education initiatives, timely release of counterpart funds, and consistent programme delivery could enhance participation and improve the overall effectiveness of the intervention.

**Table 5.** Distribution of respondent according to constraints faced by the respondents

<b>Constraints</b>	<b>(n=123) Mean (<math>\bar{x}</math>)</b>	<b>Ranking</b>
Low level Education Attainment	8.32	2 <sup>nd</sup>
Early Marriage	6.50	10 <sup>th</sup>
Incessant communal crisis	5.87	11 <sup>th</sup>
Economic, Political and Socio-cultural issues	7.68	6 <sup>th</sup>
Poor financial resources	7.23	7 <sup>th</sup>
Poor transportation means	5.40	12 <sup>th</sup>
Lack of Counterpart Contributions	6.71	9 <sup>th</sup>
Lack of Adequate Information	8.56	1 <sup>st</sup>
Poor credit incentives	8.13	5 <sup>th</sup>
Lack of Operational Knowledge	6.88	8 <sup>th</sup>
Lack of Trust and Confidence	4.63	12 <sup>th</sup>

## **CONCLUSION**

Based on the findings of this study, it can be concluded that the majority of the respondents were within their economically active age group and predominantly married, indicating a population with significant household responsibilities and a strong motivation to improve their livelihoods. However, the level of literacy in the study area was notably low, with about 81% of the respondents having no formal education. This low educational status may limit their ability to access, interpret, and effectively utilize formal sources of information, including those related to agricultural extension programme activities and innovations.

Furthermore, the respondents were characterized by relatively large household sizes, which, while providing a source of family labour for agricultural activities, may also increase the pressure on available resources. The study also revealed that a substantial proportion of the respondents (88.0%) were able to employ additional labour in their various enterprises. This development was largely attributed to increased income generated through participation in IFAD–VCDP activities. The programme facilitated improved access to capital, inputs, and market opportunities, enabling farmers to expand their production, processing, and marketing operations. Consequently, the increased demand for labour reflects enhanced productivity, enterprise growth, and a notable level of economic empowerment among the beneficiaries. Despite these positive outcomes, the study identified low level of education as the most critical constraint to effective participation in the IFAD value chain programme, with a mean score of 8.32. This suggests that inadequate educational background among respondents may hinder their full involvement in programme activities, limit their understanding of innovations, and reduce the overall impact of the intervention.

### ***Recommendations***

In light of the above findings, the study recommends that deliberate efforts should be made to improve the educational status of farmers in the study area. This can be achieved through adult education programmes, functional literacy initiatives, and continuous capacity-building activities tailored to the needs of rural farmers.

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Enhancing farmers' knowledge base will enable them to better manage resources, adopt improved technologies, and actively participate in agricultural development programmes. Also, extension service providers should adopt more inclusive and practical communication approaches, such as demonstrations, farmer field schools, and the use of local languages, to ensure that information is effectively disseminated regardless of literacy level. There is also a need for sustained support in terms of timely funding, access to inputs, and market linkages to further strengthen the gains recorded under the IFAD–VCDP.

Overall, improving the educational capacity of rural farmers, alongside strengthening institutional support systems, will significantly enhance their socio-economic conditions, promote sustainable agricultural development, and maximize the impact of extension programmes in the study area.

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ISBN: 978-625-92209-5-6