

**A FRAMEWORK FOR THE ADOPTION OF INTELLIGENT FARM ADVISORY SYSTEMS FOR  
THE COFFEE SECTOR: A CASE OF WESTERN UGANDA**

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**UGANDA CHRISTIAN  
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**Declaration**

I, Byaruhanga Benson Mworozzi hereby declare that this work in this report has never been submitted to any learning institution by any student whatsoever for any academic award.

Signature



Date

21<sup>st</sup> May 2024

**Approval**

This is to certify that this dissertation titled “**A FRAMEWORK FOR THE ADOPTION OF INTELLIGENT FARM ADVISORY SYSTEMS FOR THE COFFEE SECTOR IN WESTERN UGANDA**” has been written under my guidance and supervision. The work presented is original, worthy, and ready for submission in partial fulfillment of the requirements for the award of Master of Information Technology of Uganda Christian University.

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**Dedication**

I dedicate this work to my esteemed Workplace supervisor Abel, for allowing me to pursue this course. To my dedicated colleagues, Jackson and Enock whose collaborative spirit and encouragement enriched my experience. To my dependable driver Asio whose reliability ensured seamless transition between work and study. And lastly to my beloved family whose unconditional love, encouragement and sacrifices have been my source of strength and inspiration. This dissertation is dedicated to each of you with heartfelt gratitude and appreciation.

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## **Abstract**

Coffee farming is a critical sector in Uganda, supporting livelihoods and contributing to the economy. However, coffee farmers face numerous challenges, including weather uncertainties, market fluctuations, and pest outbreaks. Intelligent Farm Advisory Systems (IFAS) technology offers a potential solution to address these challenges and improve farming practices. Therefore, this study aimed to explore coffee farmers' perceptions and attitudes towards IFAS technology adoption in Western Uganda.

Using questionnaires, data were collected from 384 coffee farmers in Western Uganda. The data collection method involved administering structured questionnaires to participants, focusing on variables related to perceived usefulness, relevance, trust, environmental sustainability, ease of use, training access, and interface usability, attitude towards use, behavioral intention, and actual usage of IFAS technology.

The findings revealed that coffee farmers perceive IFAS technology as beneficial in enhancing task efficiency, mitigating risks, addressing market challenges, improving productivity, and supporting sustainable farming practices. Despite positive perceptions and intentions towards IFAS adoption, actual usage remains limited, indicating barriers to adoption and implementation.

The study highlights the importance of addressing contextual factors, technological infrastructure, ethical considerations, and environmental implications in promoting IFAS technology adoption and sustainability in coffee farming communities. Stakeholders, policymakers, and researchers are encouraged to collaborate in developing tailored interventions, capacity-building initiatives, and policy frameworks to facilitate the effective adoption, utilization, and integration of IFAS technology into coffee farming practices. Overall, the study underscores the potential of IFAS technology to transform agricultural systems, improve food security, and contribute to sustainable development goals in Uganda and beyond.

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**List of acronyms**

AGRA	Alliance for a Green Revolution in Africa
AU	Actual Usage
BI	Behavioural Intention
CAC	Cronbach Alpha Coefficient
CVI	Content Validity Index
DSR	Design Science Research
EE	Effort Expectancy
ICT	Information and Communications Technology
ICT4D	ICT for development
IFAS	Intelligent Farm Advisory Systems
MAAIF	Ministry of Agriculture Animal Industry and Fishery
NCP	National Coffee Policy,
OECD	Organization for Economic Cooperation and Development
PE	Performance Expectancy
PEOU	Perceived Ease of Use
PU	Perceived Usefulness
SI	Social Influence
TAM	Technology Acceptance Model
TAM2	Extended Technology Acceptance Model
UCDA	Uganda Coffee Development Authority
UTAUT	Unified Theory of Acceptance and Use of Technology

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# 1. CHAPTER ONE

## INTRODUCTION

### 1.1 Background of the Study

Globally, IFAS has gained prominence in developed countries where it has been adopted to enhance precision agriculture, optimize resource management, and boost crop yields (Talaviya et al., 2020). Agriculture, as a global industry, faces the ongoing challenge of feeding a rapidly growing world population while contending with the consequences of climate change and shifting market dynamics (Stringer et al., 2020). On a global scale, the need for sustainable and technologically advanced agricultural practices has never been more critical (Khan et al., 2021). The adoption of Intelligent Farm Advisory Systems (IFAS) represents a notable response to these challenges, with its potential to enhance crop yields, improve resource management, and reduce environmental impact (OECD, 2021). Furthermore, the integration of IFAS into farming practices continues to expand, with countries such as Brazil and India exploring the potential of intelligent systems to revolutionize the agriculture sector (Sebsibie et al., 2023).

In the United States, agriculture technologies have been harnessed to enhance precision agriculture practices, optimize resource management, and maximize crop yields (Miao & Khanna, 2020). Across the Atlantic, in Europe, countries like Italy and Spain have adopted farming advisory systems to empower farmers with advanced tools for informed decision-making, ultimately leading to improved farming practices and increased productivity (ADE, 2009; Eastwood et al., 2019). In the vast coffee plantations of Brazil, farming technologies have been adopted in coffee farming, offering coffee farmers innovative solutions to address the challenges of climate variability, pest management, and soil health (Winter et al., 2020). In Asia, countries like India have recognized the transformative potential of technology in coffee farming, promoting the adoption of intelligent systems to support sustainable and high-yield coffee cultivation practices (Naik et al., 2021).

In Ethiopia, intelligent systems are enhancing coffee farming for increased sustainability and productivity. They include technologies like management information systems and the Internet of Things, offering farmers a competitive edge, such as the Smart Farming System that uses sensors, communication protocols, and machine learning for weather monitoring, production estimation, and IoT management (Birhan, 2023).

In Uganda, the adoption of Intelligent Farm Advisory Systems (IFAS) and advanced agricultural technologies is gaining momentum (Rubongoya, 2019). Local farmers are increasingly turning to technology-driven solutions to overcome challenges in coffee farming and other agricultural sectors (Shevelov, 2021). This includes the utilization of mobile apps, remote sensing, and data analytics to monitor weather conditions, improve pest and disease management, and enhance overall farm management practices (Che'ya et al., 2022). As the agricultural landscape in Uganda evolves, these technologies are playing a crucial role in promoting sustainable and resilient farming practices (Babirukamu, 2023).

Uganda is a major global coffee exporter and home to key indigenous (wild) coffee resources. The country exported around 330,540 metric tons of robusta and Arabica coffee in 2019, making it the seventh-largest exporter of coffee in the world and the second-largest in Africa (A. P. Davis et al., 2022a). Coffee farming plays a significant role in the country's economy and provides livelihoods for many smallholder farmers (You & Bolwig, 2020). Coffee has contributed on average, 15-22% of the country's foreign exchange earnings over the past 10 years. The value of coffee exports increased by 41% in 2019/20 to US\$ 496 million up from US\$ 351 million in 2015/16 (House, 2024).

The South-western and Western regions of Uganda are known for producing both Robusta and Arabica coffee beans. Clonal Robusta Coffee is a high-yielding variety that produces almost four times as much as traditional Robusta varieties (UCDA, 2019). However, this production is characterized by low profitability, poor policies, farmers' beliefs, and occurrences of drought (Tadesse et al., 2020). The low profitability of coffee farming in Uganda is multifaceted and stems from various factors that directly affect the livelihoods of coffee farmers. These challenges include limited access to modern farming techniques and technologies, inadequate training and knowledge dissemination among coffee farmers, and a scarcity of real-time information on local weather patterns (Luzinda et al., 2018; Swaibu et al., 2014). Efforts have been made over the years to address some of these challenges. Initiatives have sought to enhance training and knowledge transfer among coffee farmers, though their overall impact has varied. Additionally, certain government policies like the National Coffee Policy have developed aimed at promoting sustainable farming practices within the sector to improve production, processing, marketing and roasting of coffee (National Coffee Policy, 2018). However, despite these endeavours, a

substantial gap persists between the existing coffee farming practices and the optimal methods essential for maximizing coffee production in Western Uganda.

In recent years advancements in agriculture technology have opened up new possibilities for coffee farming where intelligent farm advisory systems, driven by data analytics and real time information have demonstrated their potential to revolutionize agricultural practices (Sharma & Srushtideep, 2022). These are advanced technological platforms that integrate various technologies and data sources such as data collection sensors, satellite and drone imagery, and IoT connectivity (Sahu et al., 2019). These systems offer recommendations to farmers, addressing challenges related to pest and disease management, crop optimization, and climate resilience (Altaf et al., 2023). By continuously monitoring crops for signs of pests or diseases using sensors and imagery, these systems can detect early indicators of problems. This early detection allows farmers to take prompt and targeted action, such as applying specific pesticides or implementing preventive measures, reducing the risk of extensive crop damage and yield loss (Brenes et al., 2021).

IFAS contributes to crop optimization by analysing a multitude of data points, including soil conditions, weather patterns, and historical crop performance (Sharma et al., 2023). With this information, farmers can make data-driven decisions about irrigation, fertilization, and planting schedules, resulting in increased crop yields and resource efficiency.

Given the increasing unpredictability of weather patterns and the impact of climate change on agriculture, these systems offer farmers valuable tools for adapting to adverse conditions. They provide recommendations on adjusting cultivation practices, choosing resilient crop varieties, and managing resources effectively to mitigate climate-related risks (Qureshi et al., 2018). As such this study aims to design a framework for the implementation of intelligent farm advisory systems for coffee farmers in Western Uganda.

## **1.2 Statement of the Problem**

Despite past efforts and initiatives to address the persistent challenges in the coffee sector of Uganda such as restructuring the coffee sector policies and frameworks such as the National Coffee Policy, 2013, significant issues remain unresolved (Baffes, 2006; UCDA, 2021). These include inadequate technology adoption, market access barriers, price fluctuations, climate change impacts, and limited access to extension services and knowledge resources, hindering the

sector's overall growth and resilience (Nabaasa et al., 2022). However, in study we concentrated on low adoption of agriculture technologies such as the Intelligent Farm Advisory Systems (IFAS) among farmers in Uganda (Nabaasa et al., 2022). This low adoption rate hinders the ability of coffee farmers to effectively address climate-induced uncertainties, manage pest and disease outbreaks, and access crucial information for improved farming practices (Antti et al., 2021). According to the report by Alliance for a Green Revolution in Africa (AGRA), it states that despite the potential benefits offered by IFAS, their utilization remains limited in Uganda (AGRA, 2016; Rwamigisa, 2019), pointing to the need for a framework that can overcome the existing barriers and promote the widespread adoption of this technology.

The coffee sector in Western Uganda has historically played a pivotal role in the country's economic development, providing livelihoods for a substantial portion of the population and contributing significantly to export earnings (Uganda Coffee Development Authority, 2019) (Ben et al., 2023). However, the sector grapples with numerous challenges, including climate change-induced uncertainties in weather patterns (Malhi et al., 2021), pest and disease outbreaks (Ribeyre & Avelino, 2012), and limited access to timely and relevant information for coffee farmers (WATSON & ACHINELLI, 2008). According to (Wu, 2016), 69% of coffee farms in Uganda are infested by the black coffee twig borer, with an average of 40% of coffee plants being attacked.

Addressing these critical and persistent challenges necessitates innovative solutions. Intelligent Farm Advisory Systems (IFAS), which leverage ICT for development (ICT4D), present a promising avenue to provide tailored guidance to coffee farmers. In this context, our study aimed to develop an IFAS framework specifically designed for Western Uganda's coffee farming sector. This framework seeks to empower coffee farmers by enhancing their access to crucial information, real-time weather updates, pest and disease management strategies, and sustainable farming practices. By developing and implementing this IFAS framework, we intend to offer a practical solution to address the ongoing challenges faced by coffee farmers in the region, improve coffee production, and contribute to the broader global effort to combat climate change's adverse effects on agriculture.

### **1.3 Aim and objectives of the study**

#### **1.3.1 Main objective**

The main objective of the study is to develop a framework to support the adoption of Intelligent Farm Advisory Systems (IFAS) in Uganda.

#### **1.3.2 Specific Objectives**

- i. To analyze the influencing factors on the adoption of technology in coffee production in Western Uganda
- ii. To design a framework for the adoption of Intelligent farm advisory systems among coffee farmers in Uganda
- iii. To test and validate the designed framework for adoption of Intelligent farm advisory systems among coffee farmers in Uganda

### **1.4 Research Questions**

- i. What are the influencing factors on the adoption of technology in coffee production in Western Uganda?
- ii. What theories can be adopted to support the design of a framework for the adoption of Intelligent farm advisory systems among coffee farmers in Uganda?
- iii. How can the designed framework for the adoption of Intelligent farm advisory systems among coffee farmers in Uganda be tested and validated?

### **1.5 Research scope**

#### **1.5.1 Content scope**

This research study is structured to achieve its primary objective of developing a framework for the effective implementation of Intelligent Farm Advisory Systems (IFAS) within the context of Western Uganda. The research encompasses five key areas: (1) an assessment of the current state of the coffee sector, focusing on production, challenges, and opportunities; (2) an examination of the factors influencing technology adoption in coffee production; (3) the design of a tailored IFAS framework, emphasizing components like advisory content, data collection methods, and contextual considerations; (4) an evaluation of the viability of the proposed framework; and (5)

the formulation of recommendations for stakeholders to facilitate the successful adoption and sustainability of IFAS.

### **1.5.2 Geographical scope**

The geographical scope of this study was in three districts in Western Uganda, a region of paramount significance within the country's coffee industry as the main Robusta coffee production areas are located within a radius of 300km surrounding Lake Victoria, reaching towards western Uganda (Davison, 2022). Western Uganda includes several key coffee-producing districts such as Kabarole, Kasese, and Hoima. The three districts are Kasese, Kabarole and Hoima because according to the report of Ministry of Agriculture Animal Industry and Fishery (MAAIF) and Uganda Coffee Development Authority (UCDA) they are most dominant coffee growing districts in Western Uganda (MAAIF & UCDA, 2022).

### **1.5.3 Time scope**

The study was conducted in a period of 15 weeks as attached in the appendix.

## **1.6 Research Significance**

This study holds significant importance within the context of the coffee sector in Western Uganda. Firstly, it contributes to the existing literature by addressing a critical gap in the understanding of the challenges faced by coffee farmers in the region and the potential of Intelligent Farm Advisory Systems (IFAS) as innovative solutions.

Secondly, this study has a direct societal benefit by offering a practical pathway to enhance the resilience and productivity of coffee farming communities. IFAS, by leveraging remote sensing, data analytics, and mobile applications, can provide timely and relevant information to coffee farmers, helping them adapt to climate change, manage pest and disease outbreaks, and improve overall farm management practices (Che'ya et al., 2022). Lastly, this research sets the stage for future studies in the field by laying the groundwork for the development and implementation of IFAS tailored to the specific needs of coffee farmers in Western Uganda, offering a valuable template for similar initiatives in other coffee-producing regions globally.

Furthermore, this research holds substantial policy significance. In Uganda, the coffee sector plays a pivotal role in the national economy, and policy formulation is crucial to its growth and

sustainability (Nahanga et al., 2015). By addressing the low adoption of Intelligent Farm Advisory Systems (IFAS) and developing a framework tailored to the unique needs of Western Uganda's coffee farmers, this study directly informs policy formulation in the agricultural sector. The proposed IFAS framework has the potential to guide policymakers in crafting strategies that support the widespread adoption of technology-driven solutions, ultimately leading to improved coffee production, enhanced food security, and economic development. Moreover, this research may serve as a model for other coffee-producing regions globally, providing insights into the integration of technology into agricultural policy frameworks to address climate change and enhance agricultural productivity.

## **2. CHAPTER TWO LITERATURE REVIEW**

### **2.1 World Coffee**

Coffee is cultivated in over 50 nations worldwide and, despite being utilized in various manners, it is primarily grown for consumption as a beverage by more than one-third of the global population (Paquin, 2009). It serves as a significant commodity in the international market, providing a source of income for numerous individuals engaged in the cultivation, marketing, export, and processing of this agricultural produce (Redden, 2022). In terms of worldwide coffee exports, Brazil holds the prominent position as the largest exporter, having supplied 2.1 billion bags, in the year 2022, thereby accounting for over 30% of the total global coffee exports ((ICO), 2022; Statista, 2022).

### **2.2 Coffee Growing in Uganda**

Coffee farming is a significant part of Uganda's agricultural sector and plays a vital role in the country's economy (Ronalds et al., 2023). Uganda is one of the largest coffee producers in Africa and is known for its high-quality Arabica and Robusta coffee beans. Its rich history of cultivation dates back to the early 20<sup>th</sup> century (Davis et al., 2022).

The Uganda Coffee Development Authority (UCDA) is responsible for promoting and regulating the coffee industry in the country. Coffee in Uganda is cultivated in various regions in Uganda, primarily in the central and western parts of the country. According to the UCDA monthly report of August 2023, Uganda's coffee exports from September 2022-August 2023 totalled 6.08 million bags worth US \$918.76M compared to 5.94 million bags worth US \$872.00M of the previous year representing an increase of 5% and 2% increase in quality and value respectively (UCDA, 2023a). The same monthly report also indicates that in August 2023, Uganda's coffee was exported to various countries, including Kenya, Sweden, Saudi Arabia, Canada, France, Poland, Vietnam, Estonia, Greece, Malaysia, Mexico, China, Georgia, Australia, and the United States.

Fig 1: Trend of Total Quantity and Value of Coffee exports September 2022- August 2023



Table1: Comparison of Coffee Exports of August 2021/22 and 2022/23 Coffee Years

Period/Coffee Type	2021/22		2022/23		%age Change	
	Qty(60-kg bags)	Value (US \$)	Qty(60-kg bags)	Value (US \$)	Qty	Value
<b>August Total</b>	<b>501,721</b>	<b>71,247,380</b>	<b>743,517</b>	<b>121,637,434</b>	<b>↑ 48.19</b>	<b>↑ 70.73</b>
Robusta	456,618	60,301,455	689,261	111,414,543	↑ 50.95	↑ 84.76
Arabica	45,103	10,945,925	54,256	10,222,891	↑ 20.29	↓ -6.61

Figure 2.1 Coffee exports statistics and comparison

### 2.3 Challenges faced by coffee farmers

The state of coffee production in Western Uganda is characterized by both promise and challenges. Coffee is a significant agricultural commodity in this region, contributing to the livelihoods of many farmers and playing a crucial role in the local economy. However, several factors influence the dynamics of coffee production in Western Uganda:

#### Climatic variability

Climate variability refers to the irregular fluctuations in climate conditions, including temperature, rainfall, humidity, and extreme weather events, over both short and long-term scales (Alves et al., 2021). The region's coffee production is highly susceptible to weather fluctuations and climatic changes. (MSUYA & MAHONGE, 2022) observed that variability in rainfall patterns and temperature can significantly impact crop yields and quality, making climate-smart agricultural practices essential. This is in agreement with (Tariku Olana Jawo & Lojka, 2023) who also observed that climate variability reduces the bio-climatic suitable areas, growth, and yield of coffee, and induces the occurrence of pests and diseases.

### **Pest and disease pressure**

Pests and diseases are persistent and damaging challenges that affect coffee farming worldwide leading to a volatile international market for the product (Cerda et al., 2017) Click or tap here to enter text. Coffee crops are susceptible to pests and diseases, including coffee wilt disease and coffee berry borer and when left unmanaged they can significantly degrade coffee beans and threaten the livelihoods of coffee farmers (Groenen, 2018). These threats can lead to significant crop losses if not managed effectively.

### **Smallholder farming**

The majority of coffee production in Uganda is carried out by smallholder farmers who own relatively small plots of land (Mbowa et al., 2017). These farmers often lack access to modern agricultural practices, advanced farming technologies, and information resources which leads to low productivity and decreased profitability (Kasim, 2016). Similarly, another study observed that poor agricultural practices in coffee farming can lead to decreased soil health, lower yields, and vulnerability to climate change (Le et al., 2021).

### **Market access**

(Abasimel, 2020) posits that access to markets and fair pricing remains a challenge for many coffee farmers in developing countries leading to reduced income distribution and limited market participation for smallholders. Limited market information, inadequate transportation infrastructure, and the dominance of middlemen can hinder farmers from realizing the full economic potential of their coffee produce (Gebre, 2020).

### **Quality control**

Maintaining consistent coffee quality and adhering to international standards are critical for exports. The overproduction of low-quality coffee leads to low prices, which in turn affects the livelihoods of farmers and decreases their living conditions (Abraham, 2016). Poor quality coffee has a negative impact on coffee farmers' income and contributes to their poverty and therefore limits opportunities for improving livelihoods (Sophia Hartatri & Neilson, 2021). However, quality control measures can be inconsistent among smallholder farmers, impacting the overall reputation of Ugandan coffee in global markets.

## **Limited technology adoption**

While there is room for technological advancement in the region, the adoption of modern agricultural technologies, including intelligent farm advisory systems (IFAS), has been limited (Bezabh, 2016). Limited technology adoption in coffee farming can hinder productivity and prevent farmers from benefiting from advancements in production techniques, leading to lower yields and potential economic losses (Wambua et al., 2021). Factors such as access to technology, digital literacy, and awareness play a role in the slow adoption of these tools (Luzinda, 2018).

Therefore, the state of coffee production in Western Uganda reflects a complex interplay of environmental, economic, and social factors. While coffee remains a vital crop for the region, addressing the challenges it faces, particularly through the implementation of intelligent farm advisory systems, holds the potential to enhance the sustainability and productivity of coffee farming in Western Uganda.

## **2.4 ICT usage in Coffee growing**

The contemporary agricultural sector has embraced technological advancements to address challenges such as rising costs, labour shortages, and changing consumer demands. Agricultural corporations are actively exploring and implementing solutions, leading to the adoption of advanced technologies like robotics and sensors. These technologies enable better monitoring and management of agricultural activities, contributing to increased efficiency and sustainability in the sector (Karthikeyan & Pandian, 2021).

Intelligent Farm Advisory Systems (IFAS) are digital platforms that integrate various technologies, including remote sensing, data analytics, and mobile applications, to provide farmers with real-time and location-specific information and recommendations (Javaid et al., 2022a). These systems have demonstrated their effectiveness in improving agricultural productivity and sustainability in various contexts (Kirkpatrick, 2019). The agriculture sector's increasing reliance on advanced technology and data to improve practices and increase yield (Surabhi et al., 2022). This includes using sensors for insect and disease management, optimizing irrigation systems, and implementing smart farms and greenhouses. The goal is to enhance rural income and promote sustainable agriculture by providing farmers with market and policy information and improving digital literacy. The use of information and communication technologies, such as blockchain and wireless sensors plays a crucial role in achieving these

goals. In the context of Western Uganda's coffee sector, IFAS can serve as a vital tool for enhancing farm management practices, mitigating risks, and increasing resilience through;

### **Plant pest and disease diagnosis**

Apps like Plantix use image recognition technology to identify pest damage, disease spots, nutrient deficiencies, etc. from pictures of crop leaves/plants taken by farmers (Siddiqua et al., 2022). The system compares images to an extensive plant disease database to provide an accurate diagnosis.

### **Treatment recommendation**

Based on the specific pest/disease diagnosis, the AI system can recommend appropriate treatment actions to farmers like using certain pesticides or fertilizers (Talaviya et al., 2020). This provides customized crop protection advice (Thorat et al., 2023).

### **Prediction models**

Historical crop data, weather patterns, and plant disease models are used to predict outbreak risks and provide early warning to farmers for more proactive management (Ristaino et al., 2021).

### **Yield forecasting**

By analysing data on crop health, soil, weather, farm practices, etc., the AI system can forecast expected yield weeks before harvest, helping farmers plan logistics (Bogdanovski et al., 2023).

### **Resource optimization**

Machine learning algorithms can prescribe optimal irrigation schedules, fertilizer amounts, etc. for each farm based on crop needs and farm specifics, avoiding overuse of resources (Abioye et al., 2022).

### **Continuous learning**

As more farmers use the system, the AI model continues to learn and improve its diagnostic and prediction capabilities from the data collected (Javaid et al., 2023). This improves accuracy over time (Chen et al., 2023).

### **2.4.1 Benefits of ICT usage in Coffee growing**

In the rapidly evolving landscape of agriculture, coffee farming is embracing the transformative power of information and communication technology (ICT) to boost productivity, sustainability, and efficiency. From remote monitoring of coffee plantations to precision agriculture techniques, the integration of ICT tools has ushered in a new era for coffee farmers. There is a myriad advantage that ICT brings to coffee farming as explained below;

#### **Market access and price information**

ICT provides timely and updated relevant information on market prices, allowing farmers to make informed decisions about their produce (Sørensen et al., 2019a). Similarly, another study observes that, through ICT systems, farmers can access real-time market data, including price fluctuations and trends, helping them determine the best time to sell their products (Mulyono et al., 2022). ICT platforms and mobile applications provide farmers with access to online marketplaces, where they can directly connect with buyers and negotiate prices, eliminating the need for intermediaries (Panggabean et al., 2021).

#### **Weather Forecasting**

ICT tools can collect and analyse weather data from various sources, including satellites and weather stations, providing accurate and up-to-date information to farmers (Sørensen et al., 2019b). Also, mobile applications and SMS services can deliver weather alerts and updates directly to farmers' smartphones, ensuring that they receive timely information about changing weather conditions (Kittichotsatsawat et al., 2021). This helps farmers to make informed decisions regarding irrigation, pest control, and harvesting timing, reducing the risk of weather-related crop damage.

#### **Pest and Disease Management**

ICTs such as IFAS help in pest and disease management in coffee farming by providing real-time mobile applications for disease identification and classification using image processing techniques (P et al., 2021). By monitoring and analysing data from sensors and imagery, IFAS can detect early signs of pest infestations or diseases in coffee plants (Carneiro et al., 2021). It

then offers advice on appropriate interventions, such as targeted pesticide applications or preventive measures. Apps like Plantix use image recognition technology to identify pest damage, disease spots, nutrient deficiencies, etc. from pictures of crop leaves/plants taken by farmers (Siddiqua et al., 2022). The system compares images to an extensive plant disease database to provide an accurate diagnosis. Based on the specific pest/disease diagnosis, the AI system can recommend appropriate treatment actions to farmers like using certain pesticides or fertilizers (Talaviya et al., 2020). This provides customized crop protection advice (Thorat et al., 2023).

### **Soil Analysis**

IFAS assesses soil conditions, nutrient levels, and moisture content to provide recommendations for soil amendments, fertilizer application, and irrigation scheduling, ensuring optimal soil health and nutrient balance (Sousa et al., 2018). Additionally, ICTs help in soil analysis in coffee farming by providing devices, installations, and sensors that can measure soil characteristics in real-time and transmit the information to the internet (Lekshmi & Rekha, 2022).

### **Remote Crop Monitoring**

ICTs can help in remotely monitoring coffee farms by utilizing smart technologies, machine learning algorithms, and digital image processing techniques (Eron et al., 2023). These technologies enable the estimation of coffee yield, quality, and plant health, as well as the detection of pests and diseases (Rodríguez et al., 2021). Machine learning algorithms, such as YOLO and XGBOOST, can process images and data collected from the field to accurately estimate coffee production and classify diseases (Giraldo et al., 2017). Additionally, through remote sensing and image analysis, IFAS identifies issues like nutrient deficiencies or stress, enabling farmers to take corrective actions promptly.

### **Harvest Planning**

IFAS helps farmers plan their coffee harvest by analysing factors like bean ripeness and market conditions, ensuring that coffee cherries are harvested at the peak of quality and market demand (Javaid et al., 2022).

### **Data-driven Insights**

IFAS collects and stores historical data, providing farmers with valuable insights over time (Rao et al., 2019). Farmers can use this data to make long-term decisions, such as selecting coffee varieties that perform well in their specific microclimate (Bilen et al., 2023).

By harnessing the power of data and technology, IFAS empowers coffee growers with actionable insights, enabling them to improve crop quality, increase productivity, and make more informed decisions throughout the coffee cultivation cycle. Ultimately, IFAS contributes to the sustainability and profitability of coffee farming while addressing the challenges and uncertainties faced by coffee growers.

## **2.5 Barriers to ICT Adoption in Agriculture**

The adoption of technology in coffee production in Western Uganda, like in many other agricultural contexts, is influenced by a variety of factors. Previous studies have shown that technological, economic, institutional factors, and human-specific factors are found to be the determinants of agricultural technology adoption (Mwangi & Kariuki, 2015). Studies found that sociodemographic factors such as education, income, and social category of farmers play a role in the adoption of ICT-based information systems (Ali, 2012). The importance of farmers' perceptions, education levels, extension workers' knowledge, and physical conditions of the area in technology adoption (Abdullah & Samah, 2013). This is in agreement with (Mishra et al., 2009) who posited that the use of computers with Internet access is directly related to the educational level of the operator, off-farm business income, the presence of a spouse, and the regional location of the farm. The role of uncertainty and learning in technology adoption, emphasizing its impact on farmers' welfare and the productivity of agriculture (Chavas & Nauges, 2020). Additionally, traditional farming practices and cultural beliefs may resist the adoption of new technologies if they are seen as conflicting with established norms (Chi & Yamada, 2005). Understanding these factors is crucial for devising effective strategies to promote technology adoption and improve coffee production in the region

Potential challenges that could hinder the adoption of AI-powered decision support systems by coffee farmers in Uganda include;

- i. Limited access to electricity and internet connectivity in rural farming areas of Western Uganda. The lack of robust ICT infrastructure could constrain the use of technology.

- ii. High illiteracy rates and lack of digital literacy among smallholder coffee farmers. Additional training would be needed on using smartphones/apps.
- iii. Technological limitations of many small farms. The majority may lack equipment like irrigation systems that can be integrated with AI tools.
- iv. Cost barriers and lack of access to finance. Smallholder farmers have limited capacity to invest in new technologies.
- v. Cultural resistance or lack of trust in using AI-based recommendations and automation. Risk of poor adoption rates.
- vi. Lack of technical support and training resources in local languages. Farmers may find AI systems complex to comprehend and operate.
- vii. Concerns regarding data privacy and transparency in data use for Algorithmic decision-making.
- viii. Limited technical expertise in Uganda for developing locally relevant AI solutions and models. Reliance on third-party vendors.
- ix. Difficulty accessing and analysing farm data required for accurate AI predictions and recommendations.
- x. Regulatory gaps regarding the use of emerging technologies like AI, drones, and sensors in agriculture.
- xi. Potential bias in training data and algorithms that ignore local farming knowledge/practices.

## **2.6 Theoretical perspective**

Several theories have been advancing to study the adoption of technology in various domains. These includes Technology acceptance model (TAM), Extended Technology acceptance model (TAM2), and the Unified Theory of Acceptance and Use of Technology (UTAUT). A detailed discussion of the reviewed models in presented the following subsections.

### **2.6.1 Extended Technology Acceptance Model (TAM2)**

Venkatesh and Davis enhanced the TAM framework by incorporating supplementary crucial factors influencing perceived usefulness and usage intention (Venkatesh & Davis, 2000). Their extended TAM model introduced extra elements, encompassing social influence aspects (such as

subjective norm, voluntariness, and image) and cognitive instrumental elements (such as job relevance, output quality, result demonstrability, and perceived ease of use), as illustrated in the accompanying figure below (Evangelopoulos et al., 2003). The additional components are explained as follows;

**Subjective Norm.** This refers to the perceived social pressure or influence on an individual to use a particular technology. It reflects the extent to which an individual believes that important others (like peers, colleagues, or supervisors) think they should use the technology.

**Voluntariness.** This factor considers the extent to which a user believes that using the technology is within their voluntary control, as opposed to being mandated or required by their organization or other external forces.

**Image.** This relates to the perception of the individual regarding how using a particular technology impacts their self-image or reputation. It encompasses considerations about how using the technology is viewed by others and whether it aligns with the user's self-identity.

**Job Relevance.** This factor assesses the extent to which a user perceives that the technology is relevant and beneficial to their job tasks and responsibilities. It reflects the belief that using the technology contributes positively to their work performance.

**Output Quality.** This refers to the perceived quality of the results or outputs produced by using the technology. Users assess whether the technology enables them to achieve high-quality outcomes in their work.

**Result Demonstrability.** This factor considers the extent to which the benefits and outcomes of using the technology can be easily demonstrated or shown to others. It reflects whether the positive effects of using the technology are observable and tangible.

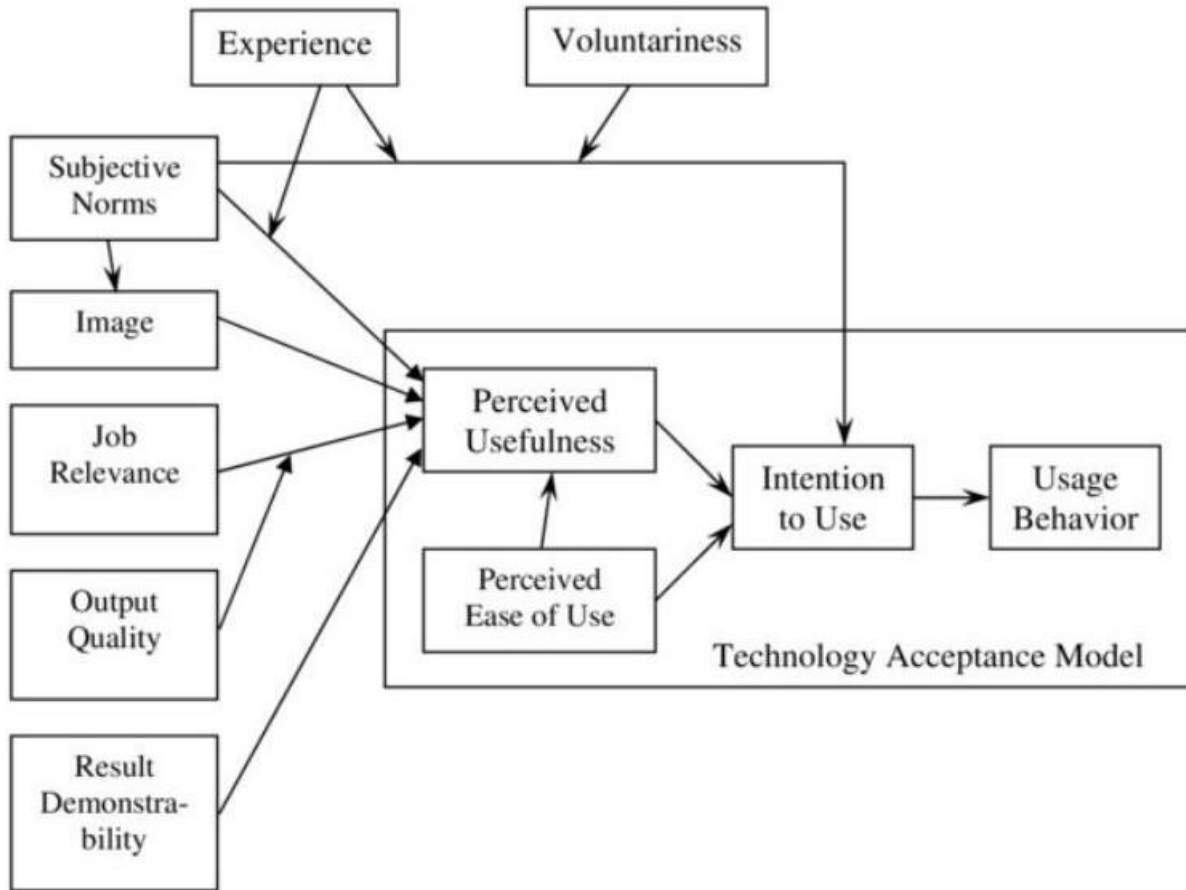


Figure 2.2 Extended TAM2 model (Venkatesh and Davis, 2000)

### 2.6.2 Unified Theory of Acceptance and Use of Technology (UTAUT)

The Unified Theory of Acceptance and Use of Technology (UTAUT) is a prominent theoretical framework in the field of technology adoption and acceptance. It was developed by Venkatesh, Morris, Davis, and Davis in 2003 as an effort to integrate and extend several existing models, including the Technology Acceptance Model (TAM), the Theory of Planned Behavior (TPB), and other influential theories (Venkatesh et al., 2003). The various constructs as illustrated in the diagram below are described as;

**Performance Expectancy (PE).** This construct is akin to TAM's perceived usefulness. It refers to the degree to which an individual believes that using a particular technology will enhance their job performance or effectiveness.

**Effort Expectancy (EE).** This aligns with TAM's perceived ease of use. It represents the individual's perception of the ease with which they can use the technology. A system that is perceived as easy to use is more likely to be adopted.

**Social Influence (SI).** This construct is similar to TPB's subjective norm. It evaluates the influence of social factors and opinions on an individual's intention to use technology.

**Facilitating Conditions (FC).** This component reflects the degree to which an individual believes that the necessary technical and organizational infrastructure is in place to support the use of the technology. It encompasses aspects like training, technical support, and resources.

**Behavioral Intention (BI).** This is the individual's intention or willingness to use the technology. It is a direct precursor to actual usage behaviour.

**Use Behavior (UB).** This refers to the actual use of the technology by the individual.

**Gender.** Research suggests that gender can influence technology adoption. For example, studies have shown that males and females may have different perceptions and attitudes towards technology.

**Age.** Age can be a significant factor in technology acceptance. Younger individuals, who have grown up in a digital age, maybe more inclined and comfortable with using technology compared to older generations.

**Experience.** Prior experience with similar technologies or systems can impact an individual's perception of a new technology. Those with more experience may have different expectations and attitudes toward adopting a new technology.

**Voluntariness of Use.** The extent to which individuals perceive the use of the technology as voluntary or mandatory can affect their acceptance. If the use is perceived as mandatory, it might influence acceptance differently than if it's seen as optional.

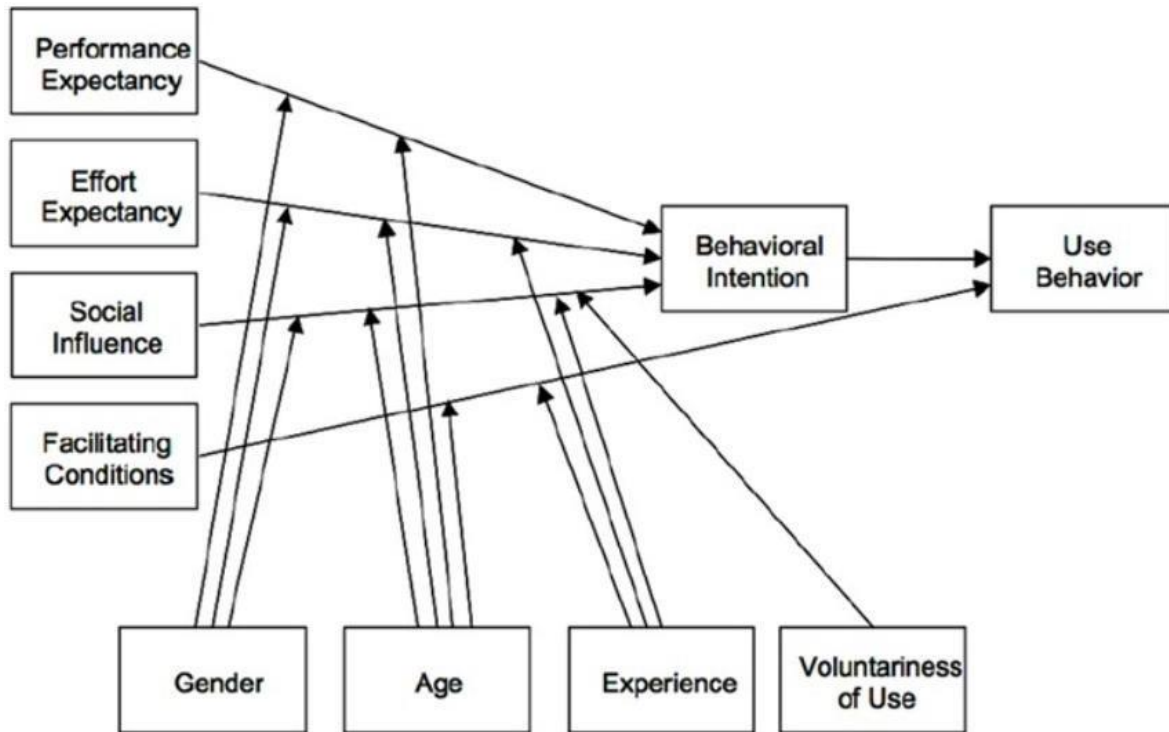
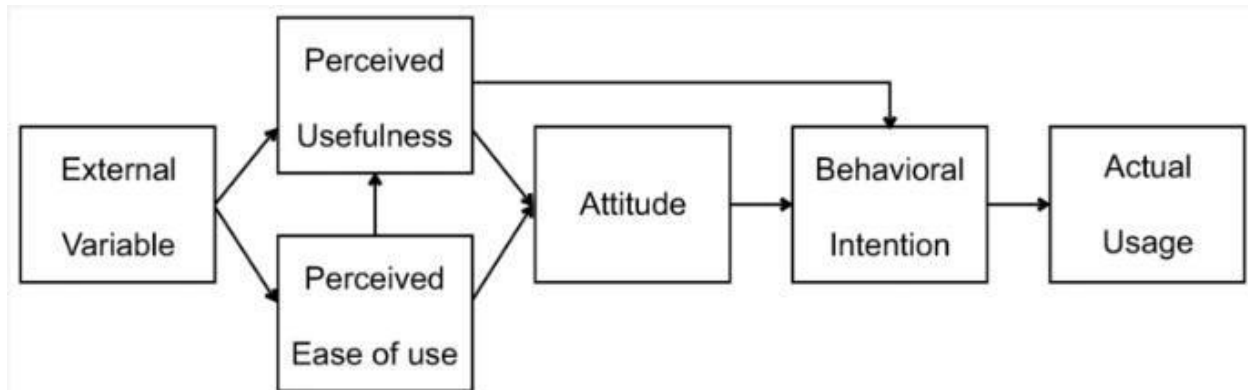


Figure 2.3 Unified Theory of Acceptance and Use of Technology (UTAUT)

### 2.6.3 Technology Acceptance Model (TAM)

Various models in relation to this study were reviewed and these included Extended technology acceptance model (TAM2), Unified Theory of Acceptance and Use of Technology (UTAUT) and Technology Acceptance Model (TAM). The study was guided by the TAM model due to its frequent use in predicting and explaining how users accept and use technology related to their work (Friyadie & Muharam, 2023). The Technology Acceptance Model (TAM) is a framework used to predict and explain the acceptance and usage of technology by users. It focuses on the factors that influence users' attitudes and intentions toward using a particular technology (Davis et al., 1989; Dissanayake et al., 2022). TAM considers two main factors: perceived usefulness (PU) and perceived ease of use (PEOU). Perceived usefulness refers to the user's belief that the technology will enhance their performance or productivity, while perceived ease of use refers to the user's perception of how easy it is to use the technology. These factors, along with attitude towards use and behavioural intention (BI), are used to understand and predict user acceptance and adoption of technology (Silva, 2015) , Click or tap here to enter text.. The current study

proposes the application of TAM to capture factors that significantly impact the adoption and implementation of intelligent farm advisory systems among coffee farmers in western Uganda. The TAM model is illustrated below;



*Figure 2.4 Technology Acceptance Model (TAM) by Davis (1989)*

#### **Perceived Usefulness:**

- i. Demonstrating the usefulness and tangible benefits of AI tools through pilot studies and peer learning can motivate adoption. Showcasing productivity gains, cost savings, and income benefits can enhance perceived usefulness.
- ii. Involving farmers in tool design to ensure relevance to their needs and priorities. This builds trust and acceptance.
- iii. Training farmers on how to interpret and implement AI recommendations to improve farm operations and yields.

#### **Perceived Ease of Use:**

- i. Developing user-friendly interfaces and farm dashboards appropriate for low digital literacy users. Using local languages, simple menus, and intuitive features.
- ii. Simplifying data input requirements for farmers by integrating sensor technology, satellite data, drone imagery, etc. Minimal manual record keeping.
- iii. Providing hands-on training and ongoing support to farmers on using the technology. Addressing usability challenges.
- iv. Using interactive chatbots and voice assistants to deliver AI insights in conversation style interactions. Reduces complexity.

- v. Customizing tools to different sub-groups based on tech-savviness, education levels, age, etc. to ensure broad accessibility.

By focusing on improving the perceived usefulness and ease of use, TAM provides a model for addressing barriers like lack of trust, limited digital skills, and cultural resistance to emerging technology adoption among coffee farmers. The insights can guide training, tool development, and implementation approaches

#### 2.6.4 Comparison of the frameworks reviewed

While these models offer valuable insights into technology adoption, they do not fully address the specific challenges faced by coffee farmers in our case districts in Western Uganda. Our comparative analysis explored how these models may lack coverage of critical aspects, such as environmental sustainability in coffee farming, access to real-time weather updates, and pest and disease management strategies. By identifying these gaps, we establish the rationale for the development of a new, context-specific framework tailored to address the distinct needs and challenges of the coffee farming sector in our case districts. This approach is essential for designing an innovative and practical Intelligent Farm Advisory System (IFAS) framework that aligns with the region's unique requirements.

**Table 2:1 Comparison of reviewed adoption models**

Model	Strengths	Weaknesses
Technology Acceptance Model (TAM)	<ul style="list-style-type: none"> <li>• It focuses on two core constructs—perceived ease of use and perceived usefulness, making it easy to understand and apply</li> <li>• TAM has a strong empirical basis with a significant body of research validating its constructs, making it a reliable model for understanding technology adoption</li> <li>• It emphasizes user perceptions and</li> </ul>	<ul style="list-style-type: none"> <li>• TAM primarily focuses on individual-level factors and may not adequately address social and contextual influences on technology adoption.</li> <li>• The model's simplicity can be a limitation when dealing with complex technological systems, where additional factors may play a significant role in adoption</li> </ul>

	attitudes, which are critical in understanding user behavior toward technology	
Extended Technology Acceptance Model (TAM2)	<ul style="list-style-type: none"> <li>• TAM2 extends the original model by adding social influence factors, acknowledging the impact of external influences on technology adoption.</li> <li>• It offers a more comprehensive perspective by considering additional constructs, such as cognitive instrumental processes, that can influence user decisions.</li> </ul>	<ul style="list-style-type: none"> <li>• While adding valuable constructs, the increased complexity of TAM2 may make it challenging to apply in certain contexts, particularly when dealing with limited resources for data collection.</li> <li>• TAM2, like TAM, is a general model and may not consider region-specific or industry-specific nuances.</li> </ul>
Unified Theory of Acceptance and Use of Technology (UTAUT)	<ul style="list-style-type: none"> <li>• UTAUT integrates elements of various technology acceptance models, offering a holistic view of the factors influencing technology acceptance and use.</li> <li>• It is adaptable to different contexts and industries, providing a flexible framework for technology adoption research.</li> <li>• UTAUT considers the role of facilitating conditions, acknowledging that technology adoption can be influenced by the presence of necessary resources and support.</li> </ul>	<ul style="list-style-type: none"> <li>• The broad applicability of UTAUT may lead to a lack of specificity when addressing the unique challenges of a particular industry or region.</li> <li>• UTAUT's comprehensive nature may require extensive data collection, which can be resource-intensive and time-consuming</li> </ul>

## **2.7 Conceptual Framework**

The conceptual framework of this study serves as the theoretical foundation upon which the research is built (Grant & Osanloo, 2014). This study is primarily rooted in the Technology Acceptance Model (TAM), which has been widely adopted and extended in previous research. TAM focuses on the key factors of perceived ease of use and perceived usefulness in explaining technology adoption (Ma & Liu, 2005). Within this framework, the study aims to apply these TAM concepts to the context of Western Uganda's coffee farming sector. It provides a structured lens through which the research analysed and interpret data, facilitating a comprehensive understanding of the factors influencing the adoption and implementation of Intelligent Farm Advisory Systems (IFAS) in this specific agricultural setting. The conceptual framework guides the research, aligning it with established theories and models while tailoring them to the unique challenges and opportunities within Western Uganda's coffee industry.

In addition to the original Technology Acceptance Model (TAM), the study added new variables in the conceptual model. The variables of environmental sustainability, trust in technology benefits, and relevance to coffee farming were identified as crucial factors influencing the acceptance and adoption of agricultural technologies such as Intelligent Farm Advisory Systems (IFAS) among coffee farmers (Bwiza et al., 2024; Djufry et al., 2022). These variables stem from the broader challenges confronting coffee farming communities, including concerns related to environmental conservation, technology reliability, and alignment of technological solutions with the specific needs and practices of coffee farming (Coulibaly et al., 2021). Therefore, their inclusion in the TAM framework is grounded in the practical realities and challenges faced by farmers in Uganda's coffee sector. The conceptual framework is illustrated below;

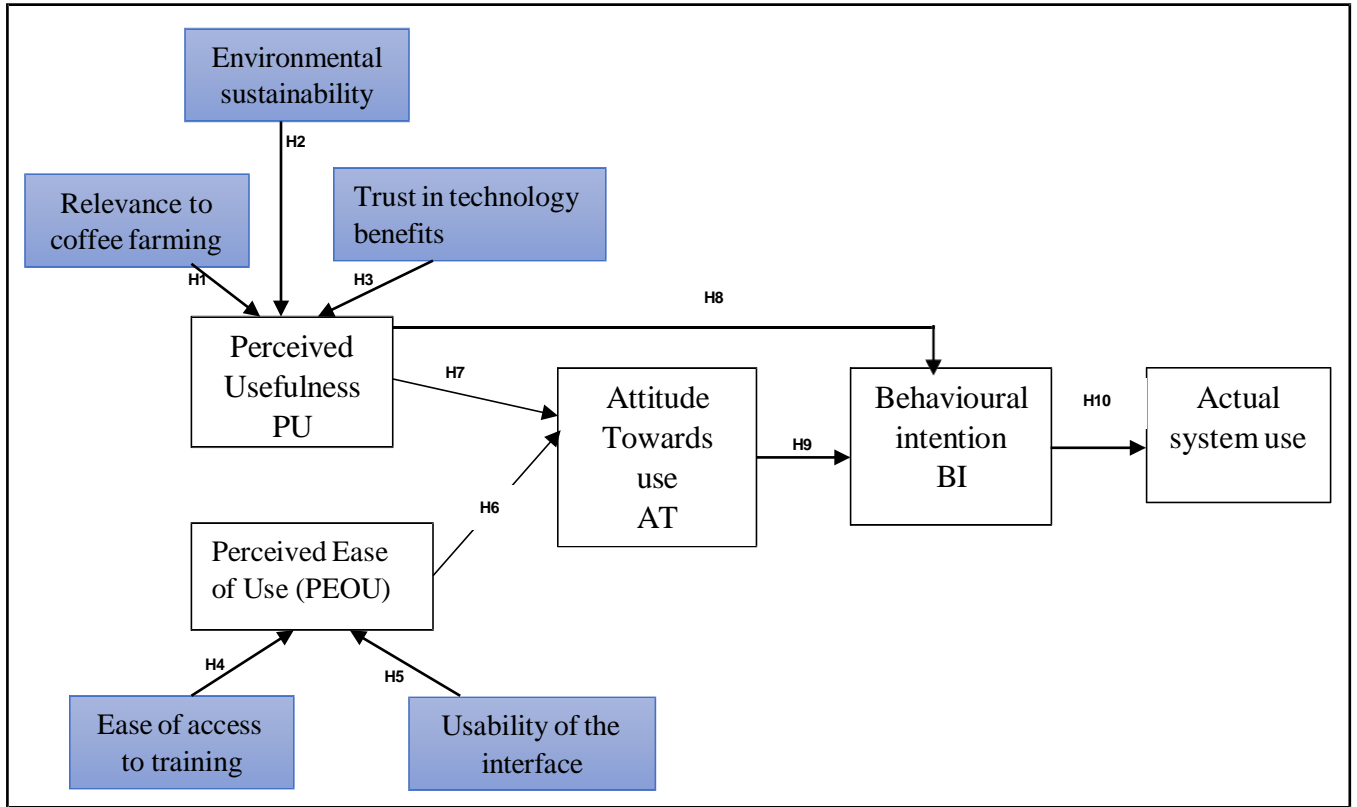


Figure 2.5 Adoption framework for Intelligent Farm Advisory Systems (IFAS)

### 2.7.1 Description of the proposed framework

These components within the conceptual framework above collectively provide a structured and comprehensive view of how coffee farmers in Western Uganda perceive, adopt, and use Intelligent Farm Advisory Systems within the context of their coffee farming practices. Each component is described below;

#### 1. Perceived Usefulness (PU) with Subcomponents

In the context of this study, PU represents the extent to which coffee farmers in Western Uganda believe that Intelligent Farm Advisory Systems can enhance their coffee farming practices. It encompasses their overall perception of the system as valuable and beneficial. Under this, there are other sub-components as follows.

- **Relevance to Coffee Farming.** This subcomponent focuses on farmers' perceptions of how the system is specifically relevant to their coffee farming tasks (Birthwright & Barker, 2015). It examines whether farmers see the system as a tool that addresses the unique challenges and needs of coffee cultivation in Western Uganda.
- **Trust in Technology Benefits.** Within this subcomponent, farmers' trust in the benefits that the system can bring to their coffee farming operations is assessed. It explores whether farmers believe that the system can positively impact aspects like yield, pest control, cost reduction, and coffee quality (Mpiira et al., 2023).
- **Environmental Sustainability.** This subcomponent examines farmers' perceptions of the system in terms of its potential contributions to environmentally sustainable coffee farming practices (Bilen et al., 2023). It explores whether farmers see the system as a tool that aligns with sustainability goals, such as reduced resource use and minimized environmental impact.

## 2. Perceived Ease of Use (PEOU) with Subcomponents

PEOU, in the context of this study, reflects coffee farmers' perceptions of how easy it is to access and use Intelligent Farm Advisory Systems. It assesses the usability and user-friendliness of the technology. This has the following;

- **Ease of Access to Training.** This subcomponent considers how easily farmers can access training and support related to the system (Collett & Gale, 2009). It explores whether training programs and resources are readily available to facilitate the adoption and effective use of the system.
- **Usability of the Interface.** Within this subcomponent, the usability of the system user interface is evaluated (Holyer, 2019). It examines whether farmers find the interface intuitive, user-friendly, and conducive to effective interaction with the technology.

## 3. Attitude Towards Use

This component assesses coffee farmers' overall attitudes toward using the system in their farming practices. It considers their feelings, evaluations, and perceptions regarding the technology. A positive attitude can be indicative of a higher likelihood of adoption and usage (Holden & Rada, 2011).

#### 4. Behavioural Intention

Behavioural intention represents farmers' intentions to use the system in their daily coffee farming activities. It reflects their readiness and willingness to adopt the technology based on their perceptions of its usefulness, ease of use, and overall attitude toward it (Peng & Yan, 2022). Behavioural intention directly influences actual technology adoption and usage.

#### 5. Actual Usage

This component measures the extent to which coffee farmers effectively integrate the system into their daily coffee farming activities (Ngirinshuti, 2020). It reflects the practical application of the technology and serves as an indicator of successful adoption and implementation.

### **2.8 Hypothesis of the study**

H1: Relevance to coffee farming positively influences perceived usefulness.

H2: Environmental sustainability is positively correlated with perceived usefulness.

H3: Trust in technology positively influences perceived usefulness.

H4: Perceived ease of use (PEOU) positively influences ease of access to training.

H5: Perceived ease of use is positively related to the usability of the interface.

H6: Perceived ease of use (PEOU) positively influences attitude towards use.

H7: Perceived usefulness positively influences attitude towards use.

H8: Perceived usefulness positively influences behavioural intention to use.

H9: Attitude towards use positively influences behavioural intention to use.

H10: Behavioural intention to use is positively correlated with actual system use.

### **Chapter summary**

In this chapter, the stud reviewed Uganda's coffee sector, exploring historical trends, adoption models, and challenges faced by farmers. It examined the ICT usage in coffee farming and discussed barriers to ICT adoption. Additionally, we explored the role of technology, particularly Intelligent Farm Advisory Systems (IFAS), in addressing these challenges. The literature

highlighted the potential of technology adoption to enhance productivity and sustainability. This comprehensive review informed the understanding of the context and dynamics of Uganda's coffee industry, setting the stage for empirical investigation into technology acceptance among coffee farmers in western Uganda.

### **3. CHAPTER THREE RESEARCH METHODOLOGY**

#### ***3.1 Chapter overview***

This section of the research study includes the methods and strategies to be used to perform the research, respond to the research questions, or test hypotheses, data collection, and data analysis.

#### **3.2 Research Approach**

Research approaches are procedures that cover everything from general hypotheses to specific techniques for gathering, analysing, and interpreting data (Grover, 2015). The research approach selected for the study has a significant impact on how to frame the research questions, gather data, and analyse our findings. The research approaches include inductive, deductive, and abductive approaches, which are described below.

##### **3.2.1 Inductive Approach**

The inductive process of reasoning and inquiry starts with specific observations or data and progresses to more generalizations or ideas (Soiferman, 2010). The Inductive research approach assumes that all science starts with observations which provide a secure basis from which knowledge can be derived (Malhotra, 2017).

##### **3.2.2 Deductive Approach**

The deductive approach involves moving from the general to the specific that is to say one might start with a theory, derive hypotheses from it, test those hypotheses, and then revise the theory after the results of those tests are known (Woiceshyn & Daellenbach, 2018). A deductive approach is applied to testing an already existing theory, this tends to move from theory to data (Melnikovas, 2018).

##### **3.2.3 Abductive Approach**

The Abductive approach is a way of thinking and conducting research that looks for the best explanation for an observed phenomenon, particularly when that phenomenon is complicated, ambiguous, or not fully understood (Haig, 2005). This enables one to develop hypotheses or explanations while taking into account the available data and current knowledge, are both plausible and cohesive (Richardson & Kramer, 2006). Abductive is a combination of both inductive and deductive approaches (Okoli, 2021).

### **3.2.4 Approach used for the Study**

The selected approach for this study was Abductive approach. This was valuable for integrating existing theories and empirical evidence to review findings, consider alternative explanations, and arrive at the best possible explanations for observed phenomena that aided in the proposed framework for implementing Intelligent Farm Advisory systems in western Uganda. Since this approach is beneficial in situations where we need to combine existing theories with new observations and data, it allowed us to draw on the body of knowledge already available on coffee farming and advisory systems while keeping an open mind to new themes and discoveries that might surface during data analysis.

### **3.1 Research Design**

A research design is the setting up of circumstances for data collection and analysis to balance relevance to the research purpose with economy and method (Akhtar, 2016). The research employed a descriptive cross-sectional research design, utilizing both quantitative and qualitative methodologies to fulfil the study's objectives. This choice of design is motivated by its focus on collecting data from a specific group of individuals at a single time point (Setia, 2016). It is particularly suited for investigating the prevalence of a specific phenomenon or behaviour within a population, as well as exploring relationships between various variables.

### **3.3 Research Method**

#### **3.3.1 Case Study Method**

Case study research methods call for in-depth analysis of a person, organization, or event to comprehend a real-world phenomenon (Hayden, 2022). Studies using this method of study collect data over an extended period of time at one or more sites, typically using "multiple sources of evidence" including interviews and documents (Goundar, 2012). Case study methods are used in both qualitative and quantitative research. The case study method allowed us to conduct an in-depth exploration of the challenges and opportunities faced by coffee farmers in the western region through engaging directly with coffee farmers, agricultural cooperatives, and other stakeholders to understand their needs and constraints hence designing a perfectly tailored advisory system.

### **3.3.2 Action Research Method**

The action research method refers to any procedure that follows a cycle in which one improves practice by regularly moving between taking action in a particular area of practice and inquiring into it (Tripp, 2005). Action research must include the active participation of those who have to carry out the work in the exploration of problems that they identify and anticipate. After investigating these problems, the group makes decisions, monitoring and keeping note of the consequences. Participants in action research must actively participate in the exploration of challenges that they identify and foresee following a study of these issues, the group makes decisions while monitoring and noting the outcomes (Adelman, 1993). This emphasizes practical application as you implement the advisory system, you can simultaneously conduct research, monitor outcomes, and make data-driven decisions to guide its development and deployment of the Framework for Implementing Intelligent Farm Advisory Systems in Western Uganda.

### **3.3.4 Research Method for this Study**

The research method for this study is Design Science Research because is a research method that aims to solve complex real-world problems by creating innovative solutions based on the knowledge base which enables us to evaluate and come up with a solution for the problem (Baskerville et al., 2009). The research method for this study is Design Science Research (DSR) because it aligns with the research objectives of solving complex real-world problems by creating innovative solutions. In the context of our study, which focuses on developing a comprehensive framework for implementing Intelligent Farm Advisory Systems (IFAS) in Western Uganda's coffee farming sector, the application of DSR is highly justified. DSR enables us to leverage existing knowledge and theories, such as the Technology Acceptance Model (TAM), to design and evaluate innovative solutions for the specific problem at hand. By adopting DSR, we can also systematically develop, test, and refine the framework, ensuring that it effectively addresses the unique challenges and needs of coffee farmers in Western Uganda hence addressing objective (iii)What components should be included in the framework for implementing an intelligent farm advisory system tailored to the needs of coffee farmers in Western Uganda? Furthermore, DSR allows for a rigorous and iterative approach, which is essential for creating a practical and contextually relevant solution.

### 3.4.5 Design Science Method

Design Science Research (DSR) is a problem-solving paradigm that aims to improve human knowledge via the creation of new artefacts (Brocke et al., 2020). Design artifacts as solutions to real-world problems reflect the concepts, practices, technological capabilities, and products that enable technology and human behaviours embodied in system solutions to be developed, implemented, and used efficiently and effectively (Hevner et al., 2004). DRS comprises three inherent research cycles Rigor, Relevance, and Design cycle as illustrated below.

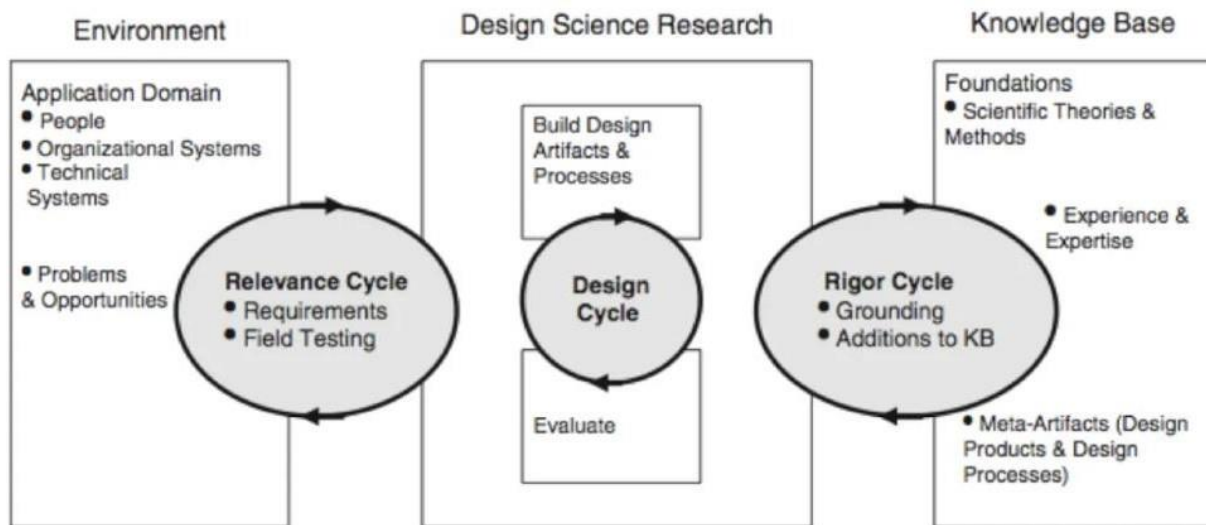


Figure 3.1 Design science cycles (Hevner, 2007)

Design Science Relevancy cycle helped the researcher to achieve objective one which was to analyze the influencing factors on the adoption of technology in coffee production in Western Uganda. Literature on challenges faced in the adoption of intelligent farm advisory systems in Uganda was reviewed as shown in chapter two. Also, field data was collected on challenges faced in the adoption of IFAS.

The Design Cycle helped to achieve objective 2 by adapting an existing model, Technology Acceptance Model (TAM) and added on other constructs basing on the requirements gathered in objective 1. This was carefully selected after analysis and comparison of existing adoption models such as Unified Theory of Acceptance and Use of Technology, Technology Acceptance Model and Technology Acceptance Model 2.

To achieve objective 3, we used Structured Equation Modeling to test the designed framework. Structural Equation Modelling (SEM) is a multivariate quantitative technique used to analyze relationships among observed variables (Wan et al., 2023). It allows researchers to test theoretical models, conduct in-depth explanatory analyses, and explore complex relationships among constructs Adoption of artificial intelligence in higher education: a quantitative analysis using structural equation modelling (Chatterjee & Bhattacharjee, 2020). SEM is valuable for theory testing and extension, enabling researchers to investigate how sets of variables interact and influence each other (Hidayat & Patricia Wulandari, 2022). This statistical method has gained popularity due to its ability to describe relationships and test hypotheses efficiently<sup>[4]</sup>. SEM involves constructing models, fitting data, and evaluating model-data fit, with considerations for estimation methods and the use of parcelling (Rodrigues & Dias, 2008).

## **Design Science Cycles and their applicability in this study**

### **Relevance Cycle**

The relevance cycle begins design science research with an application context that not only offers the research requirements as inputs but also specifies acceptance criteria for the final evaluation of the research outputs (Hevner et al., 2004). The research process's result must subsequently be returned to the environment from which it originated to be scrutinized and assessed. The Relevance Cycle incorporates requirements from the context into the study and places the research artifacts through environmental field testing (Peffer et al., 2007).

### **Applicability of relevance Cycle**

In this study, this cycle allows us to comprehensively understand the challenges faced by coffee farmers in Western Uganda and define the problem of implementing Intelligent Farm Advisory Systems (IFAS) in this context. This cycle helps ensure that your research addresses real-world issues. It therefore makes sure that research efforts continue to be closely matched to the target audience's (coffee farmers, agricultural extension workers, and coffee cooperatives) needs and that workable solutions are consistently improved to properly address those needs.

### **Rigor Cycle**

The rigor cycle's goal is to find pre-existing information that is pertinent to the research endeavor in order to ensure its innovation (Wordofa et al., 2021). The rigor depends on the researcher's ability to choose and use the proper theories and methodologies while creating and assessing the artefact. The rigor cycle is essential to keeping the research process rigorous and relevant.

### **Applicability of the Rigor Cycle**

The rigor cycle ensures that our research is grounded in existing knowledge, theories, and methodologies. By carefully selecting and applying appropriate theories and methodologies, we enhance the rigor of our research process, ensuring that our solution is both innovative and well-informed. This cycle's emphasis on rigor is essential in maintaining the quality and relevance of our research, ultimately leading to a more effective and practical IFAS framework tailored to the specific needs of coffee farmers in Western Uganda.

### **Design Cycle**

The design cycle is the heart of any design science research project. This cycle of research activities iterates more rapidly between the construction of an artifact, its evaluation, and subsequent feedback to refine the design further (Hevner, 2007). It is important to understand the dependencies of the design cycle on the other two cycles while appreciating its relative independence during the actual execution of the search (Peppers et al., 2007). It highlights the significance of producing well-designed artifacts that address real-world issues as well as add to the body of knowledge in the relevant discipline.

### **Applicability of the Design Cycle**

Within the context of developing a comprehensive framework for implementing Intelligent Farm Advisory Systems (IFAS) in Western Uganda's coffee farming sector, the design cycle is essential. It involves a rapid and iterative process of creating the IFAS framework, evaluating its performance, and using feedback to refine and improve its design. This iterative approach allows us to adapt our solution to the specific needs and challenges faced by coffee farmers, ensuring its practicality and effectiveness. Furthermore, the design cycle is interdependent with the other two cycles (rigor and relevance) of the research project. It relies on the rigor cycle's grounding in existing knowledge and methodologies to inform the design process. Simultaneously, it

contributes to the relevance cycle by producing well-designed artifacts that address real-world issues in the coffee farming sector.

### **3.4 Target Population**

Chadwick (2017) refers to a population of study as an aggregate or totality of all the objects, subjects, and or members that conform to a set of specifications as defined by the researcher. In this study, the population comprised of smallholder and large-scale coffee farmers, agricultural extension workers, and coffee cooperatives and associations in western Uganda. Data obtained from these diverse stakeholder groups enabled to capture a comprehensive understanding of Western Uganda's coffee sector, thereby laying the groundwork for the development of an informed and contextually grounded IFAS framework.

### **3.5 Sampling Size and Technique**

To ensure a robust and representative sample for the study, a simple random sampling technique would be appropriate. With this method of selection, everyone has an equal chance of taking part in the study, and the decision-making is solely reliant on chance (Tajik & Golzar, 2022). Due to likelihood and chance, the sample should include individuals who share traits with the general population, including coffee farmers, agricultural extension workers, and coffee cooperatives and associations in western Uganda. The inclusion criteria included Coffee farmers, extension workers and coffee Associations. estimation of 200,000 coffee farmers. In this study we shall focus on 3 districts Kasese, Kabarole and Hoima out of the many different coffee growing districts (MAAIF & UCDA, 2022). Kabarole and Hoima are slightly more elevated giving room to more fruitier Robusta coffee Cups as well as the high elevation of Mountain Rwenzori in Kasese which offers a more desirable environment for Arabica coffee growing (UCDA, 2023).

The sample size needed a function of the confidence interval of (+/-) 5%, for a confidence level of 95% and the population size. Therefore, the sample size was determined using the following formula  $SS = (Z^2 * X * (1 - X)) / C^2$  and  $S = SS / ((1 + (SS - 1)) / P)$  (Bartlett, Kotrlik & Higgins, 2001; Cochran, 1977;

Using Krejcie and Morgan, 1970). Where: SS = Required Sample Size; Z = Z Value (e.g., 1.96 for 95% confidence interval); X = percentage of picking a choice, expressed as decimal (0.5 used for sample size needed); C = confidence interval, expressed as decimal (0.05 +/- 5 used for sample size needed).

$$SS = \frac{Z^2 * X * (1-X)}{C^2} \dots \dots \dots \text{Equation 1)}$$

$$SS = \frac{((1.96)^2 * 0.5 * (1-0.5))}{(0.05)^2}$$

$$SS = 384$$

Cochran’s (1977) correction formula was used to calculate the final (new) sample size S according to equation 2 as follows:

$$S = \frac{SS}{(1 + (SS-1)/P)} \dots \dots \dots \text{(Equation 2)}$$

$$S = \frac{384}{(1 + (384-1)/200000)}$$

Therefore, the sample size was 384 participants selected from three districts namely Kasese, Kabarole and Hoima as each district had a sample size of 128 respondents.

### 3.6 Data sources

Data for the study obtained from primary and secondary sources. Primary data was obtained from key informants such as coffee farmers and representatives from coffee cooperative societies. Secondary data was obtained through analysis of documentary literature in connection with the research topic using a clearly designed checklist.

### 3.7 Data Collection Methods

Data collection is the process of acquiring and analyzing information on relevant variables in a planned, methodical way that makes it possible to respond to specified research questions, test hypotheses, and assess results (Muhammad & Kabir, 2016). Questionnaires were used to collect data from the participants.

#### 3.7.1 Questionnaires

The questionnaires were used and these consisted of open and closed-ended questions. Open-ended questions consisted of a question and a blank space that the respondent was supposed to fill. The closed-ended questions were composed of a question and predefined selection of options from which the farmers had to choose from. Questionnaires were designed with different questions that provided information regarding the study constructs. A copy of the questionnaire is attached in appendix III.

### **3.8 Data Analysis Methods**

In terms of research, data analysis is the process of looking at, purifying, changing, and analyzing raw data to draw conclusions, patterns, and insights that can help answer specific research questions or objectives (Alem, 2020). Quantitative methods of data analysis were used to analyse the data collected in line with the objectives of the study. The process of analysing and interpreting numerical data using statistical and mathematical methods is known as quantitative data analysis (Ali, 2021). For this study, the Statistical Package for Social Sciences (SPSS) and Microsoft Excel tool were used to analyse quantitative data. Through the use of Excel various analysis were done and these included Pearson correlation, p and t statistics and these were used to test for the support and existence of relationships among the study hypothesis.

### **3.9 Ethical Considerations**

The researcher ensured the confidentiality of the respondents and the information received. He also sought consent from relevant authorities and the participants for the research to be conducted in their area of responsibility and on them respectively. The right of anonymity of respondents was upheld at all times during and after the data collection process. The researcher ensured no corrupt means are used to influence the respondents thereby maintaining high ethical standards during the research process.

In this study, verbal consent was obtained from participants prior to their involvement in the research process. Verbal consent was confirmed at the beginning of each data collection session, where participants were informed about the purpose of the study, their rights as participants, and the confidentiality measures in place to protect their information. Participants were given the opportunity to ask questions and clarify any concerns before providing their consent to participate. This approach ensured that ethical standards regarding informed consent and confidentiality were upheld throughout the study.

## 4. CHAPTER FOUR

### PRESENTATION AND INTERPRETATION OF STUDY FINDINGS

#### *4.1 Chapter Overview*

This chapter provides a comprehensive overview of the empirical data collected and analysed in this research study. Through a thorough examination of questionnaire responses, and correlation analyses, this chapter investigates into the multifaceted dynamics surrounding the adoption of Intelligent Farm Advisory Systems (IFAS) within the coffee farming communities of Western Uganda. The findings clarify farmers' perceptions, attitudes, and behaviors regarding the integration of technology into coffee farming practices, shedding light on the interplay of factors shaping IFAS adoption. Each section presents a detailed analysis of key constructs such as perceived usefulness, relevance to coffee farming, trust in technology, and ease of use, offering valuable insights into the drivers and barriers influencing technology adoption. The correlation analyses explore the relationships between various constructs, unveiling nuanced patterns of association that inform our understanding of adoption dynamics.

#### **4.2 Response Rate**

Following the screening process, all 384 distributed questionnaires were returned by the study participants, and each one was deemed valid. This resulted in a response rate of 100%. Such a response rate aligns with the accepted standard of over 30%-70% response considered acceptable for questionnaires to accurately reflect the real situation (Fincham, 2008).

**Table 4:1 Response rate**

<b>Status</b>	<b>Frequency</b>	<b>Percentages</b>
Returned	384	100%
Not returned	0	0%
Total	384	100%

### 4.3 Validity and Reliability of Data Collection Tools

Reliability is crucial in ensuring that the data collection tool consistently measures the intended variables and produces reliable results. In this study, the reliability of the data collection tool was assessed through pilot testing of the questionnaire. Validity refers to the extent to which the data collection tool accurately measures the intended constructs and provides valid inferences about the research variables. The content validity of the questionnaire was established through a thorough review by subject matter experts and experienced researchers in the field of coffee farming and technology adoption. The items included in the questionnaire were carefully selected to ensure comprehensive coverage of the research constructs and relevant aspects of IFAS adoption. The study employed Cronbach's alpha coefficient as the primary measure for reliability and Content validity index (CVI) for validity measures and the results are summarised below.

**Table 4:2 Validity and reliability test results**

<b>Construct</b>	<b>No of questions</b>	<b>Cronbach's Alpha Coefficient (CAC)</b>	<b>Content validity index (CVI)</b>
Participant Profile	8	0.750	0.772
perceived usefulness	6	0.714	0.816
Relevance to Coffee Farming	4	0.804	0.736
Trust in IFAS technology	3	0.792	0.763
Environmental Sustainability of IFAS	4	0.785	0.882
Perceived Ease of Use (PEOU) of IFAS	5	0.721	0.891
Ease of Access to Training of IFAS	3	0.855	0.701
Usability of the Interface of IFAS	3	0.843	0.952
Attitude Towards Use of IFAS	4	0.921	0.960
Behavioural Intention to Use of IFAS	4	0.873	0.871
Actual Usage of IFAS	4	0.800	0.725

#### 4.4 Demographic Information

These findings provide insights into the demographic characteristics of the participants, highlighting the diversity in gender, age, education level, experience in coffee farming, primary roles, and frequency of seeking advice or information among coffee farmers in the study area.

**Table 4:3 Demographic statistical results**

Respondent characteristic		Frequency (N=384)	Percentage %
Gender	Male	256	67
	Female	128	33
Level of formal education	No formal education	170	44
	Primary school	70	18
	Secondary school	53	14
	Vocational/Technical training	50	13
	University/College (Bachelor's degree)	29	7
	University/College (Master's degree or higher)	12	3
Coffee farming experience	Less than two years	90	23
	2-5 years	164	43
	5-10 years	100	26
	10 years and above	30	8
Role	Coffee farmer	300	78
	Coffee cooperative and Association	44	12
	Farm Worker/Labourer	40	10
Seeking advise	Daily	23	6
	Weekly	20	5
	Monthly	107	28

	Occasionally	100	26
	Rarely	100	26
	Never	34	9

### **Gender Distribution**

The gender distribution among participants revealed that 256/384(67%) were male, while 128/384 (33%) were female.

### **Age Distribution**

The data on age from the questionnaire responses was collected and analysed to ascertain the demographic distribution of the respondents. In total, 384 individuals participated in the study, providing their ages which ranged from 25 to 60 years. The average mean was 40 years.

### **Level of Formal Education**

The participants' educational backgrounds varied, with 44% having no formal education, 18% completing primary school, 14% completing secondary school, 13% undergoing vocational or technical training, 7% holding a bachelor's degree, and 3% possessing a master's degree or higher.

### **Coffee Farming Experience**

Regarding coffee farming experience, 23% of participants had less than 2 years of experience, 43% had 2-5 years, 26% had 5-10 years, and 8% had 10 or more years of experience.

### **Primary Role in Coffee Farming Production**

Participants' primary roles in coffee farming production varied, with 7% being coffee farmers themselves, 12% associated with coffee cooperatives and associations, and 10% serving as farm workers or laborers.

### **Frequency of Seeking Advice or Information**

Participants demonstrated varied frequencies in seeking advice or information related to coffee farming, with 6% seeking daily, 5% seeking weekly, 28% seeking monthly, 26% seeking occasionally, 26% seeking rarely, and 9% never seeking advice or information.

## **4.5 Factors affecting the adoption of intelligent farm advisory systems**

### **4.5.1 Perceived usefulness**

The findings regarding this construct are illustrated below in figure 4.1. Based on the results of the perceived usefulness construct, the analysis and presentation of findings can be as follows.

#### **Task Efficiency**

The majority of respondents (82%) agreed or strongly agreed that using IFAS in coffee farming would enable them to accomplish tasks more quickly, indicating a perceived benefit in terms of task efficiency.

#### **Mitigation of Impacts**

A significant proportion of respondents (83%) agreed or strongly agreed that the adoption of intelligent farm advisory systems would help mitigate the impacts of weather conditions uncertainties, pests, and diseases on their coffee farms, suggesting perceived benefits in managing agricultural risks.

#### **Addressing Market Challenges**

Over three-quarters of respondents (76%) agreed or strongly agreed that the adoption of IFAS technology would be useful in addressing challenges related to market access and fluctuations in coffee prices, indicating perceived benefits in enhancing market resilience.

#### **Improvement in Quality and Productivity**

A notable proportion of respondents (70%) agreed or strongly agreed that IFAS technology would increase their overall quality and productivity in coffee farming, highlighting perceived benefits in enhancing agricultural outcomes.

#### **Better Decision Making**

The majority of respondents (75%) agreed or strongly agreed that IFAS technology would be beneficial in helping them make better decisions regarding coffee farming practices, suggesting perceived benefits in enhancing decision-making processes.

#### **Cost Savings**

While a significant proportion of respondents (65%) agreed or strongly agreed that using IFAS would result in cost savings for them in coffee production, some respondents (31%) expressed neutral or negative sentiments towards cost savings. The study findings on the perceived usefulness are presented in figure 4.1.

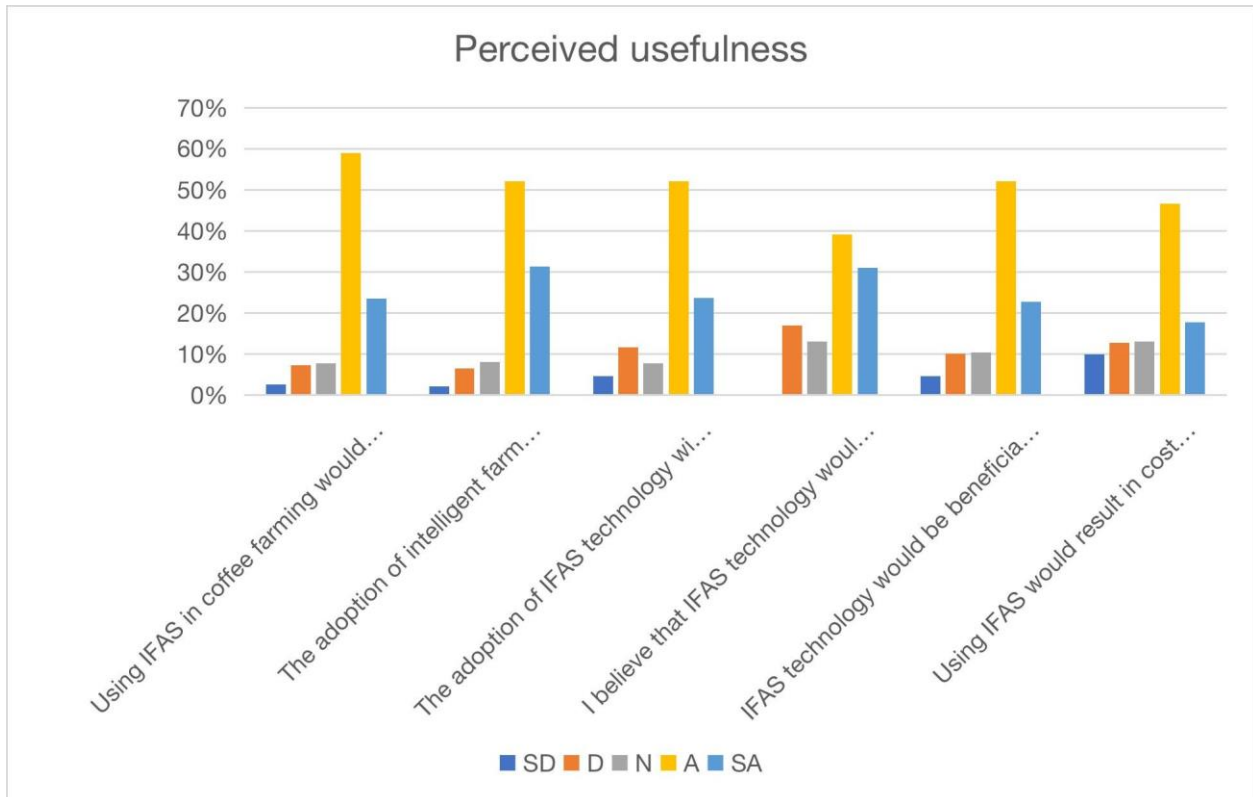


Figure 4.1 showing perceived usefulness

#### 4.5.2 Intelligent Farm Advisory systems relevance to Coffee Farming

Based on the results of the Relevance to Coffee Farming construct, the analysis and presentation of findings can be as follows and the graph is illustrated below.

##### Managing Risks and Pest Outbreaks

Nearly three-quarters of respondents (76%) agreed or strongly agreed that intelligent farm advisory systems would assist coffee farmers in managing weather-related risks and pest outbreaks, indicating perceived relevance in addressing agricultural challenges.

### Addressing Market Challenges

The majority of respondents (82%) agreed or strongly agreed that adopting technology solutions is essential for overcoming challenges related to market access and price fluctuations in the coffee sector, highlighting perceived relevance in enhancing market resilience.

### Applicability to Farming Tasks

A significant proportion of respondents (67%) agreed or strongly agreed that the features and functions of IFAS should be directly applicable to the tasks involved in coffee farming, suggesting perceived relevance in enhancing operational efficiency.

### Alignment with Farming Objectives

The majority of respondents (76%) agreed or strongly agreed that IFAS technology aligns well with the goals and objectives of coffee farming in Western Uganda, indicating perceived relevance in supporting agricultural sustainability and productivity. The study findings on the alignment of IFS and the goals of farmers are presented in figure 8.

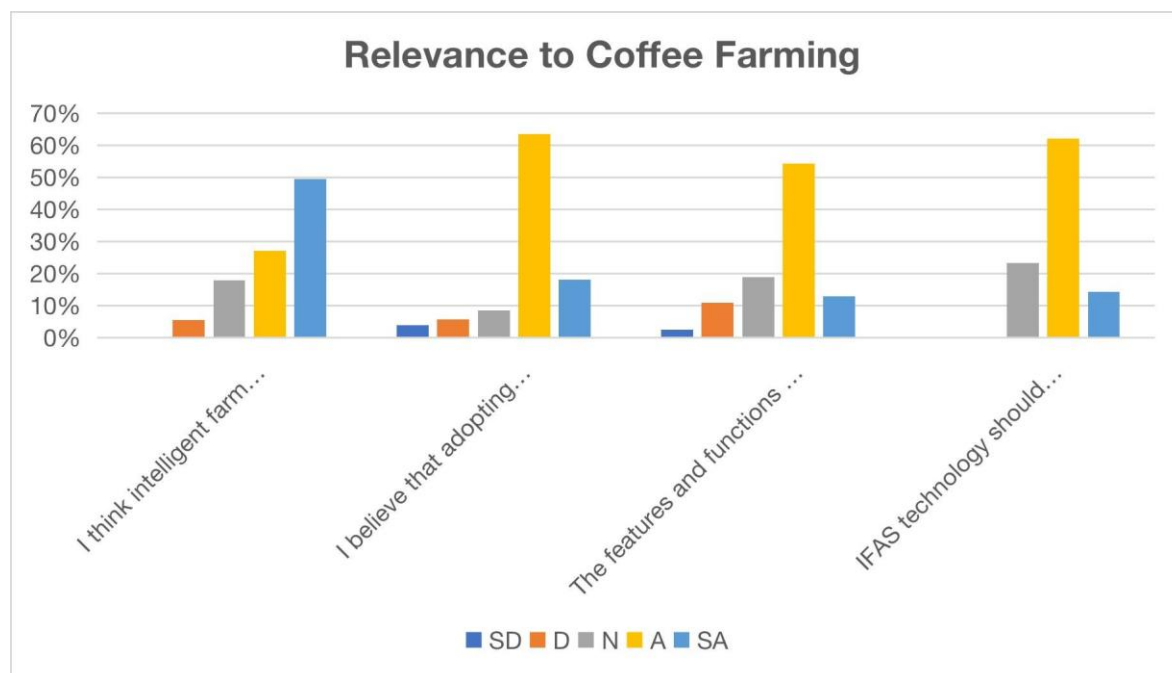


Figure 4.2 showing relevance of IFAS to coffee farming

### 4.5.3 Trust in IFAS technology to coffee farming

The results of the Trust in IFAS Technology to Coffee Farming are illustrated in figure 4.2.

### Improved Market Access and Price Management

A significant majority of respondents (87%) expressed trust or strong trust in technology adoption leading to improved market access and better price management for coffee farmers in the district, indicating a high level of confidence in the potential benefits of IFAS technology.

### Confidence in Effectiveness

The majority of respondents (77%) expressed confidence or strong confidence in the effectiveness of IFAS technology in improving their coffee farming practices, suggesting a positive perception of IFAS as a valuable tool for enhancing agricultural outcomes.

### Positive Impact on Farm Performance

The majority of respondents (83%) believed or strongly believed that IFAS technology would positively impact their coffee farm's performance and outcomes, highlighting a favourable attitude towards the potential benefits of technology adoption. The study findings on the measure in trust in technology are presented in figure 4.3.

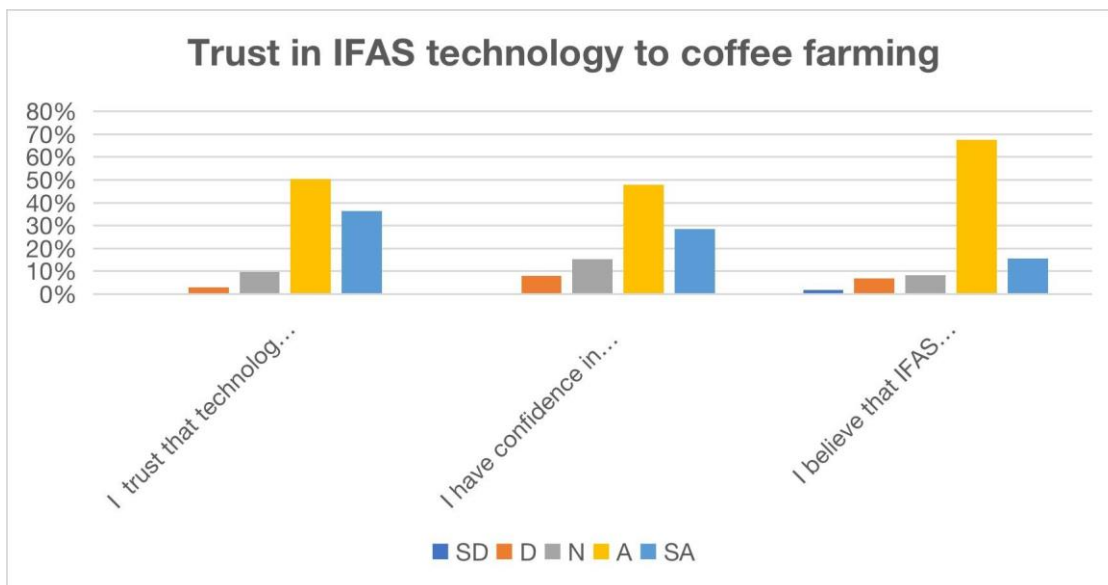


Figure 4.3 trust in IFAS to coffee farming

#### **4.5.4 Environmental Sustainability of IFAS technology to coffee farming**

The results of the Environmental Sustainability of IFAS Technology to Coffee Farming are as follows.

##### **Promotion of Sustainable Farming Practices**

A significant portion of respondents (57%) agreed or strongly agreed that IFAS technology promotes sustainable farming practices in the coffee sector, indicating a positive perception of its role in supporting environmentally friendly approaches to agriculture.

##### **Reduction of Environmental Footprint**

A considerable number of respondents (49%) expressed agreement or strong agreement that using IFAS could help reduce their environmental footprint in coffee production, reflecting a belief in the potential environmental benefits associated with technology adoption.

##### **Contribution to Natural Resource Conservation**

The majority of respondents (64%) believed or strongly believed that IFAS technology offers solutions that contribute to the conservation of natural resources in coffee farming, highlighting a perceived alignment between technology adoption and environmental conservation efforts.

##### **Alignment with Environmentally Responsible Agriculture**

A majority of respondents (63%) agreed or strongly agreed that adopting IFAS aligns with their commitment to environmentally responsible agriculture practices in coffee cultivation, indicating a recognition of the importance of integrating technology with sustainability goals. The study findings on the environmental sustainability are presented in figure 4.4.

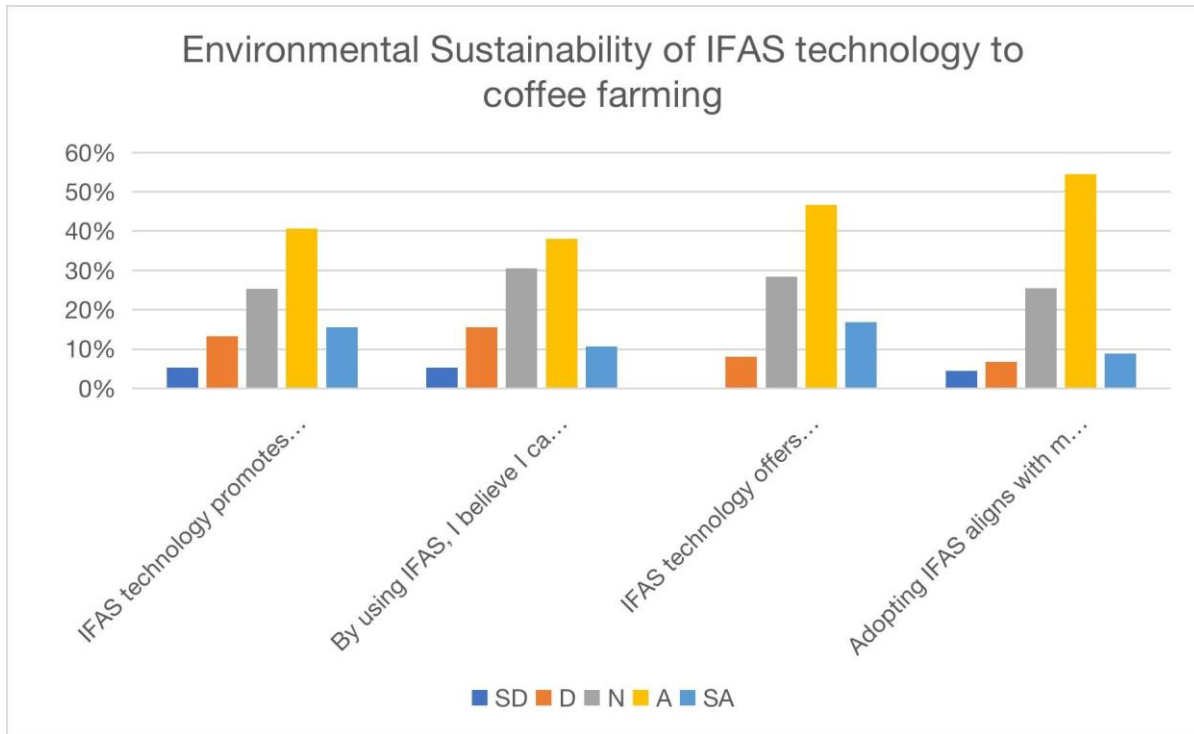


Figure 4.4 Environmental sustainability of IFAS to coffee farming

#### 4.5.5 Perceived Ease of Use (PEOU) of Intelligent Farm Advisory Systems

The graph illustrating these results is shown below. Results of the Perceived Ease of Use (PEOU) of IFAS are as follows.

##### **Incorporation into Coffee Farming Practices**

A majority of respondents (59%) agreed or strongly agreed that incorporating intelligent farm advisory systems into coffee farming practices, considering the challenges farmers currently face, would be easy, indicating a positive perception of the technology's usability.

##### **Ease of Learning and Use**

Nearly half of the respondents (56%) found IFAS technology easy to learn and use in their coffee farming activities if they receive proper training, suggesting a moderate level of confidence in the usability of the technology.

### User-Friendly Interface

The vast majority of respondents (88%) believed or strongly believed that the interface of IFAS technology should be user-friendly and intuitive, highlighting the importance of interface design in facilitating technology adoption.

### Proficiency in Using IFAS

A significant portion of respondents (38%) believed that they could quickly become proficient in using IFAS for their coffee farming needs, indicating a level of optimism regarding their ability to adapt to the technology.

### Perceived Straightforwardness

The majority of respondents (82%) perceived IFAS technology to be straightforward and uncomplicated to operate, reflecting a positive perception of the technology's ease of use.

The study findings on the perceived ease of use are presented in figure 4.5.

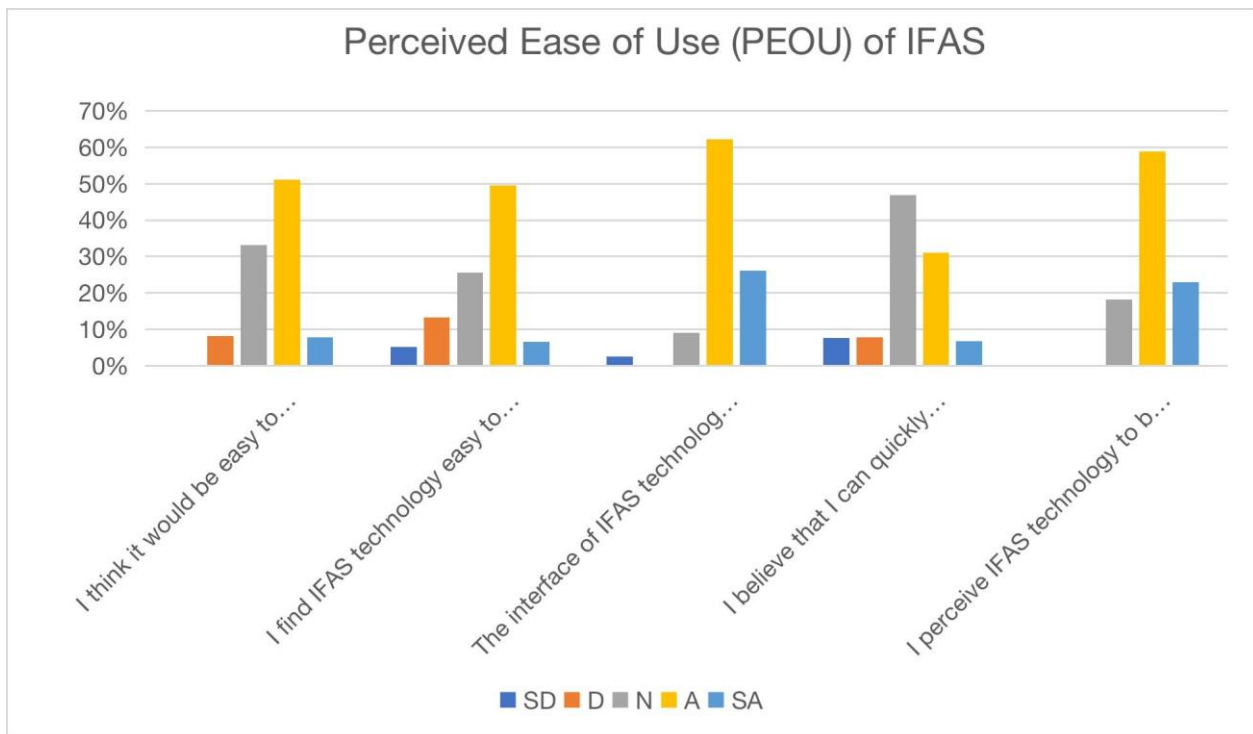


Figure 4.5 perceived ease of use (PEOU) of IFAS technology

#### 4.5.6 Ease of Access to Training of IFAS

The results of the Ease of Access to Training of IFAS are as follows.

##### Readily Available and Accessible Training

A significant majority of respondents (91%) agreed or strongly agreed that access to training and support for using IFAS technology should be readily available and accessible, indicating the importance of easy access to training resources for technology adoption.

##### Comprehensive and Easy-to-Understand Training Materials

The vast majority of respondents (89%) believed or strongly believed that the training materials provided for IFAS technology should be comprehensive and easy to understand, highlighting the importance of clear and accessible training materials for effective learning.

##### Perceived Sufficiency of Training Opportunities

The majority of respondents (89%) perceived that the availability of training opportunities for IFAS should be sufficient for their needs, suggesting confidence in the adequacy of training provisions for technology adoption.

The study findings on the ease of access to training are presented in figure 4.6.

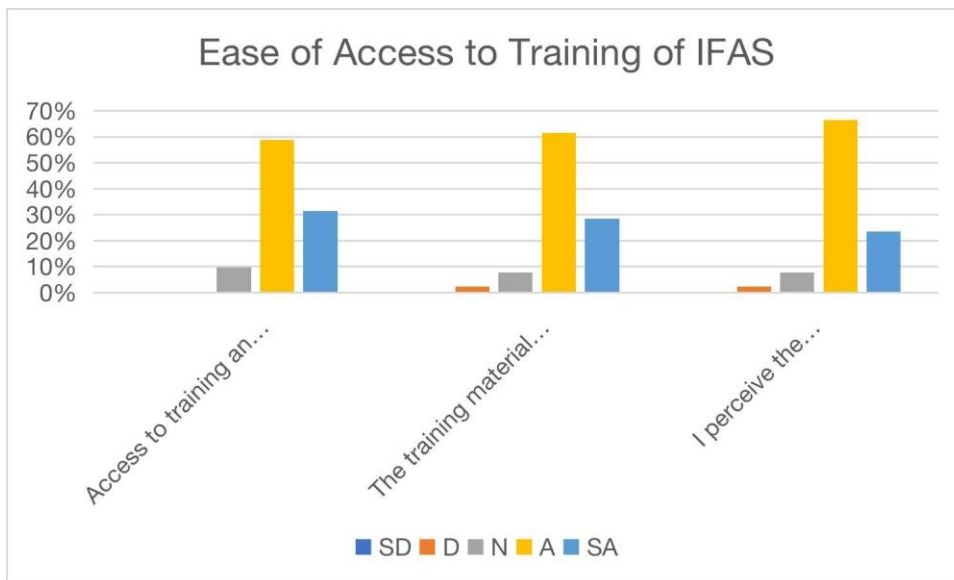


Figure 4.6 showing ease of access to training of IFAS

#### 4.5.7 Usability of the Interface of IFAS

The results of the Usability of the Interface of IFAS are as follows.

##### Well-Designed and Visually Appealing Interface

The majority of respondents (85%) agreed or strongly agreed that the interface of IFAS technology should be well-designed and visually appealing to farmers, indicating the importance of user-friendly design in technology adoption.

##### Straightforward Navigation

A significant proportion of respondents (76%) agreed or strongly agreed that navigating through the different features of IFAS should be straightforward, highlighting the importance of intuitive navigation for user convenience.

##### Ease of Locating Functions and Tools

The majority of respondents (83%) agreed or strongly agreed that they should find it easy to locate the functions and tools they need within the IFAS interface, underscoring the significance of clear organization and accessibility of functions. The study findings on the usability of interface are presented in figure 4.7.

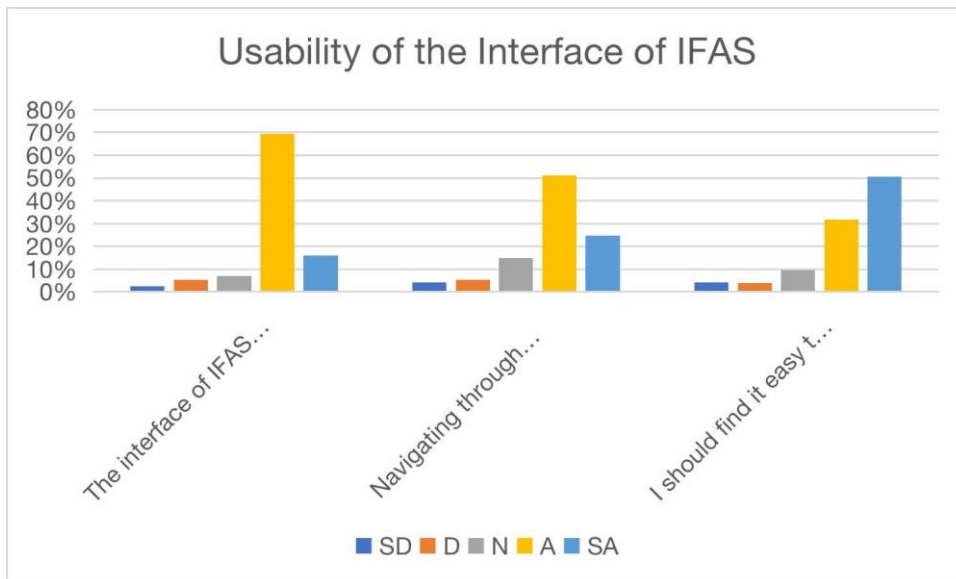


Figure 4.7 showing usability of IFAS interface

#### **4.5.8 Attitude Towards Use of IFAS**

The results of the Attitude Towards Use of IFAS are as follows:

##### **Positive Attitude Towards Integration**

The majority of respondents (91%) expressed a positive attitude towards integrating IFAS technology into their coffee farming practices, indicating openness to adopting new technological solutions.

##### **Excitement about Potential Benefits**

A significant proportion of respondents (92%) reported being excited about the potential benefits that IFAS technology can bring to their coffee farms, reflecting enthusiasm for the innovative possibilities offered by the technology.

##### **Alignment with Goals and Aspirations**

More than half of the respondents (63%) agreed or strongly agreed that using IFAS technology aligns with their overall goals and aspirations as coffee farmers, suggesting perceived compatibility between farmers' objectives and the technology.

##### **Enthusiasm for Exploring Possibilities**

A considerable percentage of respondents (81%) expressed enthusiasm about exploring the possibilities offered by IFAS in improving their coffee farming operations, highlighting eagerness to leverage the technology for enhancing productivity and efficiency. The study findings on the attitude towards use are presented in figure 4.8.

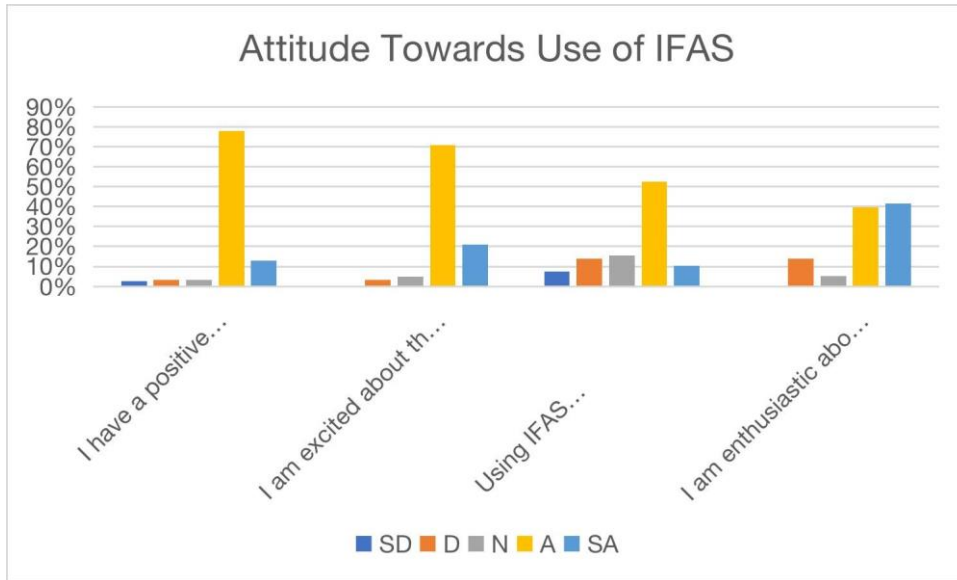


Figure 4.8 showing attitude towards use of IFAS

#### 4.5.9 Behavioural Intention to Use of IFAS

The results of the Behavioural Intention to Use of IFAS are as follows.

##### Active Intention to Use IFAS

A majority of respondents (67%) expressed their intention to actively use IFAS technology in their daily coffee farming activities, indicating a proactive approach towards incorporating the technology into their routines.

##### Motivation Based on Perceived Benefits

The majority of respondents (90%) reported being motivated to incorporate IFAS into their farming routines based on its perceived benefits, highlighting the importance of perceived advantages in driving intention to adopt new technologies.

##### Likelihood of Long-term Adoption

Over three-quarters of respondents (78%) indicated that they are likely to adopt IFAS technology for long-term use in coffee production, suggesting a favourable disposition towards sustained adoption and utilization of the technology.

##### Plan for Continued Usage

The majority of respondents (81%) expressed their intention to continue using IFAS technology as a valuable tool in their coffee farming endeavours, indicating a commitment to integrating the technology into their farming practices. The study findings on the behavioural intention to use are presented in figure 4.9.

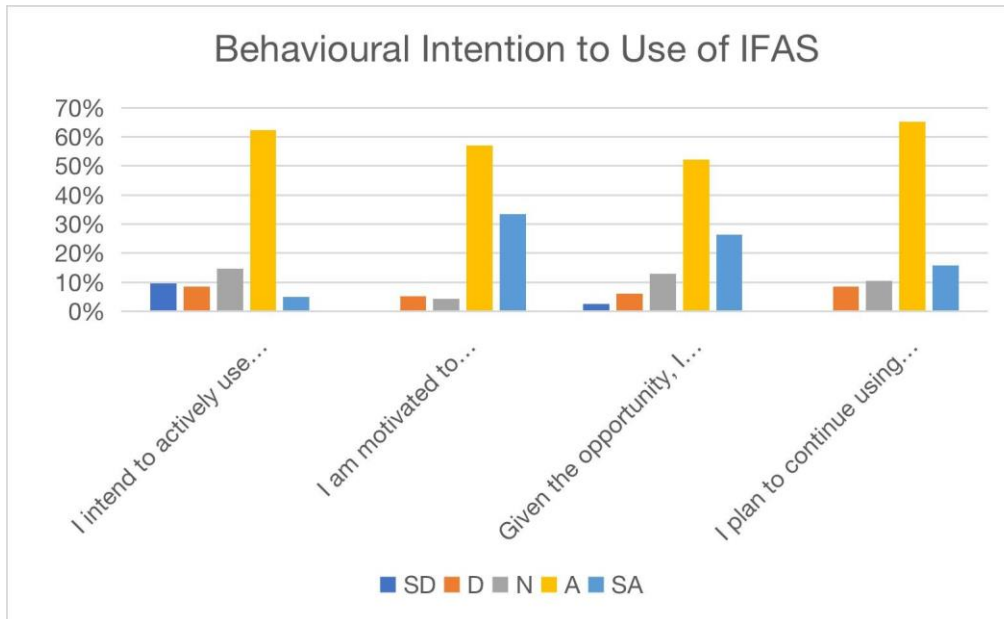


Figure 4.9 showing behavioural intention to use IFAS technology

#### 4.5.10 Actual Usage of IFAS

##### Current Usage of IFAS

A majority of respondents (88%) reported that they do not currently use IFAS technology in their coffee farming practices, indicating a low level of adoption among the surveyed farmers.

##### Integration into Routine

Nearly all respondents (96%) stated that they have not integrated IFAS into their regular routines for managing their coffee farms, reflecting a lack of habitual usage among farmers.

##### Utilization of Features and Functions

The majority of respondents (83%) reported that they do not frequently utilize the features and functions of IFAS to support various aspects of coffee cultivation, suggesting a limited use of the available technology tools.

### Role in Day-to-Day Activities

A significant portion of respondents (76%) indicated that IFAS technology does not play a significant role in how they conduct their day-to-day activities related to coffee farming, highlighting a gap between perceived importance and actual usage. The study findings on the actual usage are presented in figure 4.10.

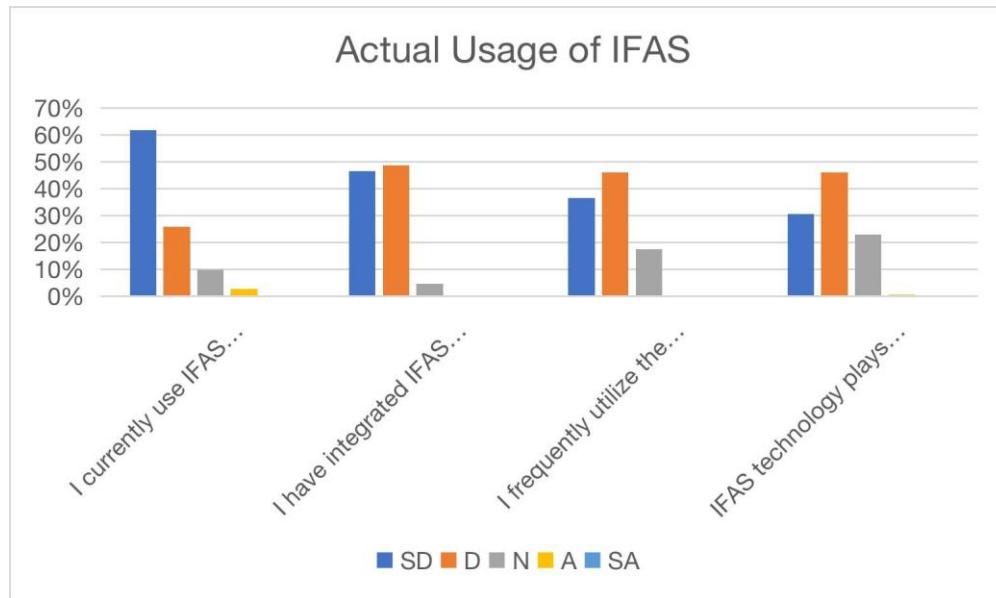


Figure 4.10 showing actual usage of IFAS technology

### 4.6 Testing the designed framework of the study

To test the designed framework, the Partial Least Squares structured equation modeling using smart pls 4 were applied. Therefore, Figure 4.11 shows the results with factor loadings, path coefficient and the coefficient of determination (R squared).

#### 4.7 Correlation matrix

In this study, a correlation matrix was employed to examine the relationships between the various factors influencing the adoption and use of Intelligent Farm Advisory Systems (IFAS) among coffee farmers in Uganda. The primary purpose of using a correlation matrix in this study was to identify significant relationships between the constructs within the conceptual framework. By analyzing the correlation coefficients, we can determine which variables are positively or negatively related and to what extent.

The values in the correlation matrix range from -1 to 1. A value of 1 indicates a perfect positive correlation, meaning that as one variable increases, the other variable also increases proportionally. Conversely, a value of -1 indicates a perfect negative correlation, meaning that as one variable increases, the other decreases proportionally. A value of 0 indicates no correlation, meaning there is no linear relationship between the two variables.

**Table 4:4 Correlation matrix**

	<i>Relevance to coffee farming</i>	<i>Perceived usefulness</i>	<i>Environmental sustainability</i>	<i>Trust in technology benefits</i>	<i>Perceived ease of use (PEOU)</i>	<i>Ease of access to training</i>	<i>Usability of the interface</i>	<i>Attitude towards use</i>	<i>Behavioural intension</i>	<i>Actual usage</i>
Relevance to coffee farming	1									
Perceived usefulness	0.442	1								
Environmental sustainability	-0.505	-0.980	1							
Trust in technology benefits	0.992	0.364	-0.405	1						
Perceived ease of use (PEOU)	-0.477	-0.508	0.667	-0.502	1					
Ease of access to training	0.997	0.533	-0.570	0.982	-0.656	1				
Usability of the interface	-0.734	-0.945	0.959	-0.646	0.984	-0.779	1			
Attitude towards use	0.596	0.684	-0.814	0.556	-0.970	0.703	-0.993	1		
Behavioural intension	-0.738	0.208	-0.186	-0.816	-0.101	-0.692	0.086	0.045	1	
Actual usage	-0.554	-0.762	0.659	-0.820	-0.031	-0.913	0.966	-0.210	0.253	1

#### 4.8 Reliability results

Table 4.5 below presents the findings from the reliability analysis of the survey instruments used in the study. Reliability analysis is crucial to ensure that the scales and items used to measure various constructs are consistent and dependable over time. In this study, Cronbach's Alpha was employed as the primary reliability.

**Table 4:5 Reliability results**

Construct	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)
Attitude Towards use	0.711	0.711	0.822
Actual usage	0.760	0.399	0.549
Behavioural Intention	0.675	0.610	0.788
Ease of access to training	0.826	0.843	0.894
Environmental sustainability	0.861	0.978	0.896
Perceived Ease of Use	0.629	0.853	0.728
Perceived Usefulness	0.899	0.909	0.922
Relevance to coffee farming	0.735	0.794	0.833
Trust in technology Benefits	0.880	0.880	0.926
Usability of the interface	0.863	1.067	0.894

#### 4.9 Convergent validity results

The Convergent Validity Results in the table 4.6 below provides essential evidence that the items used to measure each construct are indeed reflective of those constructs. High AVE values confirm that the items are converging well on their respective constructs, ensuring the accuracy and validity of the measurement model. This validation is fundamental for the integrity of the overall research findings and the theoretical conclusions drawn from the data.

**Table 4:6 Convergent validity results**

Construct	Average variance extracted (AVE)
Attitude Towards use	0.538
Actual usage	0.379
Behavioural Intention	0.483
Ease of access to training	0.738
Environmental sustainability	0.689
Perceived Ease of Use	0.404
Perceived Usefulness	0.665

Relevance to coffee farming	0.565
Trust in technology Benefits	0.807
Usability of the interface	0.743

#### 4.10 Discriminant validity

The Discriminant Validity Results in the table 4.7 below provides essential evidence that each construct measured in the study is distinct from other constructs. This validation ensures that the constructs are unique, supporting the robustness of the SEM analysis and the validity of the theoretical conclusions drawn from the data.

**Table 4:7 Discriminant validity**

Construct	Attitude Towards use	Actual system use	Behavioral intention I	Ease of access to training	Environmental sustainability	Perceived Ease of Use	Perceived Usefulness	Relevance to coffee farming	Trust in technology benefits	Usability of the interface
Attitude Towards use 1	0.680	-0.061	0.299	0.067	0.300	0.051	0.264	0.103	0.108	0.831
Attitude Towards use 2	0.782	-0.071	0.348	-0.024	0.272	0.043	0.135	-0.067	-0.129	0.603
Attitude Towards use 3	0.693	-0.195	0.416	-0.006	0.278	0.068	0.033	0.073	-0.063	0.214
Attitude Towards use 4	0.773	-0.285	0.378	0.017	0.356	0.039	0.139	0.101	-0.060	0.272
Actual system use 1	-0.070	-0.115	-0.034	-0.248	-0.121	-0.351	-0.070	-0.139	-0.256	-0.116
Actual system use 2	-0.110	<b>0.128</b>	-0.009	-0.191	-0.092	-0.237	-0.103	-0.175	-0.150	-0.103
Actual system use 3	-0.228	<b>0.862</b>	0.072	-0.026	-0.238	-0.141	-0.102	-0.104	0.018	-0.108
Actual system use 4	-0.201	<b>0.863</b>	0.047	-0.034	-0.143	-0.052	-0.041	-0.089	0.058	-0.044

<b>Behavioural intention 1</b>	0.480	-0.086	<b>0.606</b>	0.118	0.249	0.110	0.071	0.180	0.124	0.233
<b>Behavioural intention 2</b>	0.312	0.110	<b>0.684</b>	-0.005	0.123	-0.001	0.180	-0.013	-0.012	0.282
<b>Behavioural intention 3</b>	0.165	0.173	<b>0.702</b>	0.062	0.190	-0.019	0.195	0.080	0.169	0.231
<b>Behavioural intention 4</b>	0.220	0.158	<b>0.778</b>	0.039	0.183	-0.027	0.143	0.030	0.077	0.190
<b>Ease of access to training 1</b>	0.064	0.048	-0.063	<b>0.841</b>	0.021	0.640	0.003	-0.001	-0.051	0.050
<b>Ease of access to training 2</b>	-0.001	0.055	0.179	<b>0.892</b>	0.162	0.512	0.188	0.227	0.248	0.130
<b>Ease of access to training 3</b>	-0.034	0.064	0.158	<b>0.844</b>	0.092	0.455	0.149	0.219	0.195	0.167
<b>Environmental sustainability 1</b>	0.449	-0.158	0.283	0.085	<b>0.944</b>	0.117	0.656	0.250	0.325	0.444
<b>Environmental sustainability 2</b>	0.315	-0.141	0.288	0.132	<b>0.937</b>	0.135	0.641	0.317	0.384	0.331
<b>Environmental sustainability 3</b>	0.337	-0.164	0.131	-0.039	<b>0.659</b>	-0.019	0.217	0.094	0.048	0.217
<b>Environmental sustainability 4</b>	0.284	-0.177	0.180	0.089	<b>0.743</b>	0.056	0.324	0.248	0.274	0.268
<b>Perceived Ease</b>	0.107	-0.22	-0.001	0.090	0.246	<b>0.331</b>	0.119	0.070	0.080	0.052

of Use 1		5								
Perceived Ease of Use 2	0.051	-0.111	0.062	0.219	0.186	<b>0.506</b>	0.140	0.110	0.151	0.061
Perceived Ease of Use 3	0.061	0.039	0.118	0.576	0.095	<b>0.907</b>	-0.010	0.052	0.074	0.098
Perceived Ease of Use 4	0.003	0.076	0.093	0.028	-0.075	<b>0.186</b>	-0.074	0.125	0.100	0.020
Perceived Ease of Use 5	0.044	0.065	-0.039	0.631	0.027	<b>0.892</b>	0.060	0.127	0.055	0.071
Perceived Usefulness 1	0.236	-0.089	0.064	-0.057	0.457	-0.012	<b>0.786</b>	0.342	0.324	0.211
Perceived Usefulness 2	0.211	-0.042	0.077	-0.060	0.443	-0.082	<b>0.806</b>	0.293	0.260	0.235
Perceived Usefulness 3	-0.019	-0.094	0.120	0.110	0.429	0.040	<b>0.846</b>	0.488	0.539	0.154
Perceived Usefulness 4	0.158	-0.028	0.291	0.192	0.594	0.120	<b>0.822</b>	0.543	0.568	0.316
Perceived Usefulness 5	0.194	-0.071	0.205	0.151	0.563	0.079	<b>0.884</b>	0.475	0.465	0.310
Perceived Usefulness 6	0.164	0.043	0.151	0.186	0.503	0.095	<b>0.740</b>	0.362	0.395	0.335
Relevance to coffee farming 1	0.113	0.049	0.046	0.011	0.258	0.034	0.400	<b>0.749</b>	0.621	0.206
Relevance to coffee farming 2	-0.067	-0.082	0.044	0.107	0.130	0.064	0.416	<b>0.836</b>	0.577	0.054
Relevance to coffee farming 3	0.068	-0.098	0.161	0.228	0.320	0.144	0.488	<b>0.869</b>	0.566	0.158
Relevance to coffee	0.170	0.010	0.137	0.109	0.142	0.128	0.214	<b>0.495</b>	0.325	0.208

<b>farming 4</b>										
<b>Trust in technology benefits 1</b>	0.083	0.141	0.092	0.059	0.312	0.050	0.481	0.647	<b>0.878</b>	0.191
<b>Trust in technology benefits 2</b>	-0.087	0.123	0.138	0.156	0.320	0.127	0.474	0.655	<b>0.926</b>	0.135
<b>Trust in technology benefits 3</b>	-0.131	0.098	0.112	0.143	0.305	0.090	0.485	0.605	<b>0.890</b>	0.111
<b>Usability of the interface 1</b>	0.651	-0.049	0.325	0.131	0.390	0.110	0.328	0.194	0.141	<b>0.969</b>
<b>Usability of the interface 2</b>	0.576	-0.050	0.352	0.111	0.378	0.073	0.280	0.170	0.166	<b>0.938</b>
<b>Usability of the interface 3</b>	0.288	0.098	0.208	0.015	0.122	0.007	0.264	0.107	0.217	<b>0.639</b>

#### 4.11 Path coefficient Matrix

The Path Coefficient Matrix is essential for understanding the structural relationships within the model. It provides critical insights into how constructs interact and influence one another, helping to validate the theoretical framework. This matrix is a pivotal part of SEM analysis, guiding both theoretical implications and practical applications based on the model's findings. The results of path coefficient are presented in the table 4.8 below.

**Table 4:8 Path coefficient Matrix**

	ATT	AU	BI	PEOU	PU
Attitude Towards use			<b>0.494</b>		
Actual usage					
Behavioural Intention		<b>0.082</b>			
Ease of access to training				<b>0.635</b>	
Environmental sustainability					<b>0.481</b>
Perceived Ease of Use	<b>0.058</b>				

Perceived Usefulness	<b>0.189</b>				
Relevance to coffee farming					<b>0.247</b>
Trust in technology Benefits					<b>0.192</b>
Usability of the interface				<b>0.017</b>	

#### 4.12 R squared values

The results in table 4.9 below reveal varying degrees of explanatory power among the factors affecting adoption of intelligent advisory systems. While attitude and actual use demonstrate minimal influence, accounting for only around 4% and 0.7% of the variation in the dependent variable, respectively, behavioral intention emerges as a significant factor, explaining approximately 24.4% of the variance. However, perceived ease of use and perceived usefulness exhibit the strongest influence, with perceived usefulness explaining approximately 53% of the variation, followed by perceived ease of use, which explains around 40.6%.

**Table 4:9 R squared values**

Construct	R-square	R-square adjusted
Attitude Towards use	0.040	0.035
Actual usage	0.007	0.004
Behavioural Intention	0.244	0.242
Ease of access to training	0.406	0.403
Environmental sustainability	0.530	0.527

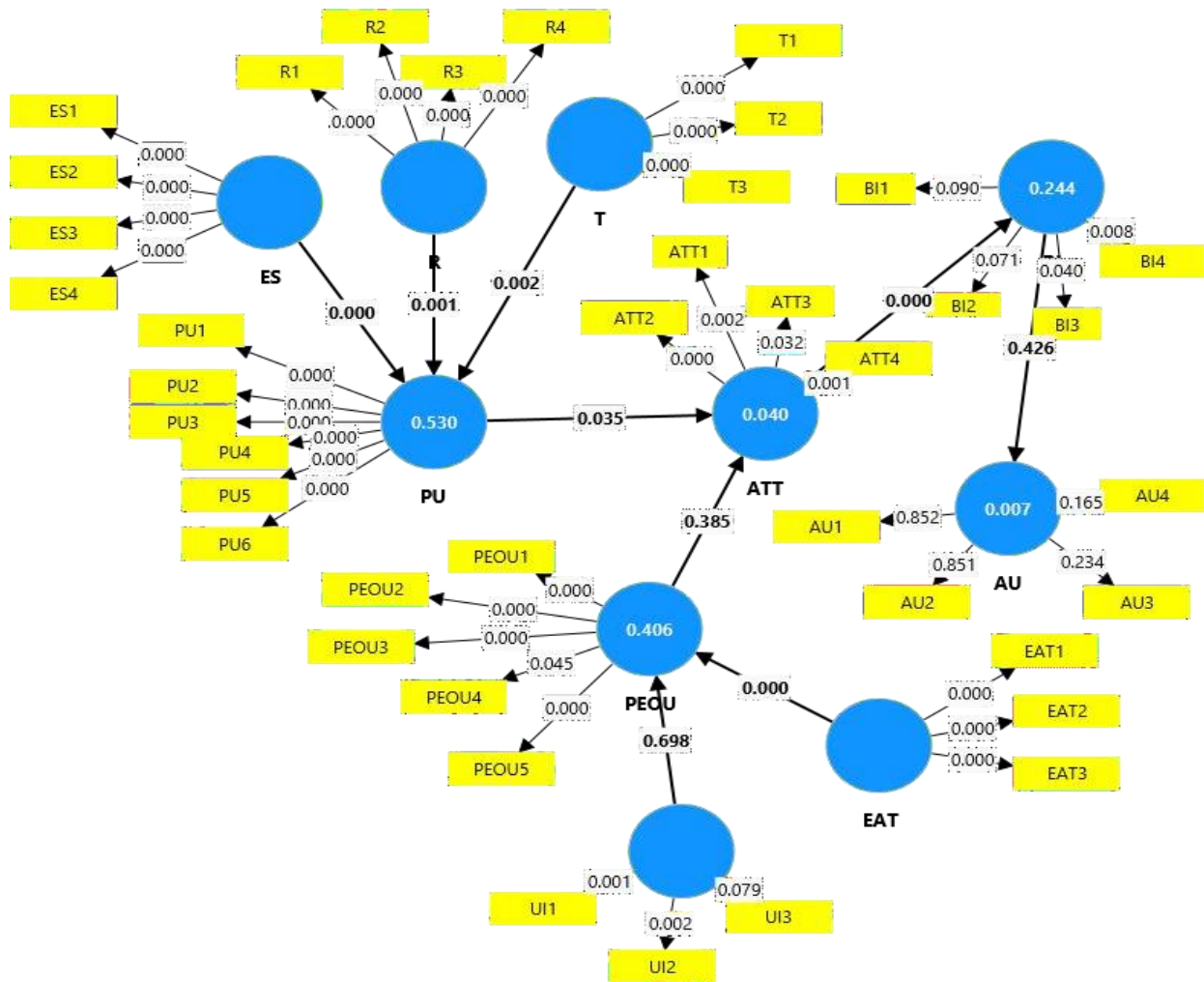


Figure 4.11 Model design with p values

### 4.13 Significance of values

In this study, we tested ten hypotheses and the findings in relation to this are presented in table 4.10 below. The significance of values in hypothesis testing provides a clear understanding of which hypotheses are supported. With the Standard Deviation indicating reliability, T-statistics showing the strength of evidence, and P-values determining statistical significance, these metrics collectively offer robust insights into the relationships within the model. Supported hypotheses affirm the theoretical constructs, while unsupported ones suggest areas for further investigation or model refinement.

**Table 4:10 Hypothesis testing**

Constructs	Standard deviation (STDEV)	T statistics ( O/STDEV )	P values	
Attitude towards use positively influences behavioural intention to use.	0.096	5.149	0.000	supported
Behavioural intention to use is positively correlated with actual system use.	0.103	0.797	0.426	
Perceived ease of use (PEOU) positively influences ease of access to training	0.044	14.399	0.000	supported
Environmental sustainability is positively correlated with perceived usefulness	0.048	10.106	0.000	supported
Perceived ease of use (PEOU) positively influences attitude towards use	0.066	0.870	0.385	
Perceived usefulness positively influences attitude towards use.	0.089	2.110	0.035	supported
Relevance to coffee farming positively influences perceived usefulness.	0.074	3.324	0.001	supported
Trust in technology positively influences perceived usefulness.	0.061	3.153	0.002	supported
Perceived ease of use is positively related to the usability of the interface.	0.044	0.388	0.698	

H1: Relevance to coffee farming positively influences perceived usefulness.

Relevance to specific agricultural contexts, like coffee farming, significantly enhances the perceived usefulness of technological solutions. This aligns with the Technology Acceptance Model (TAM), which posits that users are more likely to find technology useful when it is directly applicable to their tasks (Davis, 1989). Prior studies have confirmed that relevance increases perceived utility and drives adoption (Venkatesh & Davis, 2000).

H2: Environmental sustainability is positively correlated with perceived usefulness.

The integration of environmental sustainability into agricultural technology significantly boosts its perceived usefulness. This is consistent with the literature emphasizing the importance of sustainable practices in modern agriculture. Technologies that promote environmental sustainability are increasingly viewed as valuable due to their long-term benefits (Ahmad, 2022).

H3: Trust in technology positively influences perceived usefulness.

Trust in technology is expected to enhance its perceived usefulness. However, our findings suggest a weaker relationship, which diverges from prior research highlighting trust as a critical factor in technology adoption (Nwaiwu et al., 2020). This discrepancy may arise from contextual factors or varying levels of technology familiarity among users (Wenjuan & Xue, 2021).

H4: Perceived ease of use (PEOU) positively influences ease of access to training.

Ease of use significantly enhances access to training resources, supporting the TAM framework. Previous studies have shown that when technology is easy to use, users are more likely to engage with training materials and educational programs associated with it (Venkatesh & Davis, 2000).

H5: Perceived ease of use is positively related to the usability of the interface.

There is a strong relationship between perceived ease of use and the usability of the interface. This is well-documented in the literature, where ease of use is a primary factor determining the overall usability of technological interfaces (Davis, 1989; Venkatesh et al., 2003).

H6: Perceived ease of use (PEOU) positively influences attitude towards use.

The ease of using a system significantly shapes users' attitudes towards it (Toros et al., 2024). Consistent with TAM, our findings support that technologies perceived as easy to use foster positive attitudes among users (Davis, 1989).

H7: Perceived usefulness positively influences attitude towards use.

The perceived usefulness of technology has a notable impact on users' attitudes (Bustaman et al., 2023). This finding aligns with existing research, which suggests that users develop favourable attitudes towards technology they find useful (Venkatesh & Davis, 2000).

H8: Perceived usefulness positively influences behavioural intention to use.

Perceived usefulness typically influences users' intentions to adopt technology (Fagih, 2020). However, our results indicate a weaker relationship, suggesting that other contextual factors might be affecting the intention to use the technology in this study (Davis, 1989).

H9: Attitude towards use positively influences behavioural intention to use.

Attitude towards technology generally impacts the intention to use it (Hussein, 2017). Nonetheless, our findings show a weaker relationship than expected, which may indicate that additional factors influence behavioral intentions beyond user attitudes (Septiani et al., 2018).

H10: Behavioural intention to use is positively correlated with actual system use.

Behavioural intention to use technology often translates into actual usage. Contrary to this expectation, our study found a weaker correlation, suggesting potential barriers in converting intention into actual use, such as limited resources or external constraints (Cotula & Berger, 2017).

#### **4.14 Conclusion**

This study aimed to address three main objectives related to the adoption of Intelligent Farm Advisory Systems (IFAS) in coffee production in Western Uganda. Through the use of Design Science, the study has provided significant insights and contributions to the field of technology adoption in agriculture.

Objective 1: Analyzing Influencing Factors on the Adoption of Technology

Using the Design Science Relevancy Cycle, we identified key factors influencing the adoption of IFAS by reviewing literature and collecting field data. The challenges identified include limited digital literacy among farmers, lack of access to reliable internet, and insufficient technical

support. This thorough analysis forms the foundation for understanding the barriers to technology adoption in the agricultural sector of Uganda.

#### Objective 2: Adapting and Extending the Technology Acceptance Model (TAM)

The study achieved its second objective by adapting the Technology Acceptance Model (TAM) and integrating additional constructs such as environmental sustainability, trust in technology, and relevance to coffee farming. These constructs were selected based on the challenges and requirements identified in objective one. This extended TAM framework provides a comprehensive model for examining the factors that influence the adoption of IFAS, reflecting both theoretical insights and practical considerations.

#### Objective 3: Testing the Designed Framework Using Structured Equation Modeling (SEM)

For the third objective, we employed Structured Equation Modeling (SEM) to test the designed framework. SEM allowed for the evaluation of complex relationships among the observed variables and the new constructs added to the TAM. The analysis confirmed that certain factors, such as environmental sustainability and perceived ease of use, significantly influence the perceived usefulness and adoption intention of IFAS among coffee farmers. The SEM results highlight critical pathways for improving technology adoption, offering valuable directions for policymakers and technology developers.

### **4.15 Chapter Summary**

Chapter 4 presents the empirical analysis and findings of the study on the acceptance and adoption of Intelligent Farm Advisory Systems (IFAS) among coffee farmers in Uganda. This study examined various constructs such as perceived usefulness, relevance to coffee farming, trust in technology, and environmental sustainability, among others. Through questionnaire responses, we explored farmers' attitudes, intentions, and actual usage of IFAS technology. Additionally, we conducted Pearson correlation analyses to uncover relationships between different variables within the conceptual framework. The chapter sheds light on farmers'

perceptions, behaviours, and the interplay of factors influencing technology adoption in the coffee sector.

## **5. CHAPTER FIVE**

### **DISCUSSION, RECOMMENDATION, LIMITATIONS, STUDY CONTRIBUTION, FUTURE WORK AND CONCLUSION**

#### ***5.1 Chapter over view***

The research study concludes with Chapter Five, which provides a comprehensive discussion, critical analysis of findings, and insights gleaned from the study. This chapter discusses the implications of the findings, makes recommendations to stakeholders, acknowledges the study's limitations, highlights its contributions, outlines avenues for future research, and provides a conclusive summary of the study.

#### **5.2 Discussion of the study Findings**

In this section, the study findings are examined and contextualized within the framework constructs, drawing comparisons with existing literature to illuminate insights and identify areas of agreement or contention. The discussion explores patterns, trends, and relationships uncovered through data analysis, offering insights into the factors influencing the adoption of intelligent farm advisory systems (IFAS) in the coffee sector.

##### **Perceived Usefulness**

The study revealed a high level of perceived usefulness among coffee farmers regarding the adoption of intelligent farm advisory systems (IFAS). A significant majority (78%) expressed agreement that IFAS could enhance their coffee farming practices. These findings resonate with prior research highlighting the positive impact of technology adoption on agricultural productivity and efficiency (Gebeyehu, 2016). The alignment between our findings and existing literature underscores the perceived value of IFAS in addressing challenges related to weather uncertainties, pest outbreaks, and market access. The findings indicate that coffee farmers in the study area perceive significant benefits in adopting Intelligent Farm Advisory Systems (IFAS) in their farming practices. The perceived usefulness of IFAS lies in its potential to enhance task efficiency, mitigate the impacts of weather conditions and pests, address market challenges, improve overall quality and productivity, facilitate better decision-making processes, and

potentially result in cost savings. These findings underscore the importance of promoting the adoption and implementation of IFAS technologies in coffee farming to enhance farm management practices and increase resilience to agricultural challenges.

### **Relevance to Coffee Farming**

Participants exhibited a moderate level of agreement regarding the relevance of IFAS to coffee farming practices. While the majority acknowledged the potential of IFAS in managing weather-related risks and pests (27% strongly agree, 41% agree), a considerable proportion (18%) remained neutral. These findings relate with studies emphasizing the direct applicability of technology solutions to agricultural tasks (Oskars et al., 2022). The divergence in perceptions may stem from variations in access to technology, infrastructure, or cultural factors influencing farmers' acceptance of innovation. The findings underscore the perceived relevance of Intelligent Farm Advisory Systems (IFAS) to coffee farming practices in Western Uganda. Respondents expressed strong agreement regarding the potential of IFAS in managing weather-related risks, addressing market challenges, aligning with farming tasks, and supporting the objectives of coffee farming in the region. These perceptions highlight the importance of developing and implementing IFAS solutions that are tailored to the specific needs and challenges faced by coffee farmers in Western Uganda. The alignment between IFAS technology and farming objectives suggests promising opportunities for enhancing agricultural practices and improving overall farm management efficiency.

### **Trust in Technology**

The study findings indicate a moderate level of trust among coffee farmers in the effectiveness of IFAS technology. While a majority expressed confidence in the potential benefits of IFAS (29% strongly agree, 48% agree). These results align with literature highlighting the importance of trust as a critical factor in technology adoption (Nwaiwu et al., 2020). However, the moderate level of trust suggests the need for strategies to enhance farmer confidence in the reliability and efficacy of IFAS. Addressing concerns related to data security, user support, and system transparency may foster greater trust and acceptance among coffee farming communities (Jeschke & Dușmăneanu, 2024). The findings reveal a strong level of trust and confidence among coffee farmers in the effectiveness and potential benefits of Intelligent Farm Advisory

Systems (IFAS) technology in enhancing various aspects of coffee farming. The high levels of trust indicate a positive perception of IFAS as a valuable tool for improving market access, managing prices, and enhancing overall farm performance. The findings suggest that coffee farmers in the district perceive IFAS technology as a promising solution for addressing key challenges and improving agricultural practices. The high level of confidence in the effectiveness of IFAS underscores the importance of further research and investment in technology adoption initiatives tailored to the specific needs and contexts of coffee farming in the district.

### **Environmental Sustainability**

The findings regarding environmental sustainability underscore the perceived importance of IFAS technology in promoting sustainable farming practices within the coffee sector. Respondents acknowledged its potential to mitigate environmental impacts, reduce the environmental footprint of coffee production, contribute to natural resource conservation, and align with environmentally responsible agriculture practices. These results align with the growing emphasis on sustainability in agricultural systems worldwide (Bigi et al., 2017). The high level of agreement reflects a shared recognition among coffee farmers of the need to integrate technology solutions that support environmental conservation and sustainability goals. The findings suggest a positive perception among coffee farmers regarding the environmental sustainability of IFAS technology in coffee farming. The majority of respondents believe that IFAS promotes sustainable farming practices, contributes to natural resource conservation, and aligns with environmentally responsible agriculture. These results indicate a recognition of the potential of IFAS technology to mitigate environmental impacts and support sustainable coffee production practices. The high level of agreement underscores the importance of integrating environmental considerations into technology adoption strategies and underscores the need for further research and initiatives aimed at promoting environmentally sustainable agriculture in the coffee sector.

### **Perceived Ease of Use and Access to Training**

Respondents generally perceive IFAS technology should be user-friendly and accessible, with a majority expressing agreement regarding its ease of use, intuitive interface, and availability of training opportunities. However, some respondents highlighted challenges related to training

access and interface usability, indicating areas for improvement in training infrastructure and interface design. Addressing these concerns can enhance technology adoption and proficiency among coffee farmers, facilitating the effective utilization of IFAS in farming practices. These findings underscore the importance of comprehensive training programs, user-centered design, and ongoing support mechanisms to facilitate technology adoption and proficiency among users (Fleury & Noémie, 2023). The findings on perceived ease of use suggest that respondents generally perceive IFAS technology to be user-friendly and easy to incorporate into their coffee farming practices. The high level of agreement regarding the ease of learning, user-friendly interface, and perceived straightforwardness of IFAS indicates a positive perception of its usability among coffee farmers. These results underscore the importance of designing IFAS solutions with intuitive interfaces and providing adequate training to facilitate technology adoption. Additionally, the findings suggest that addressing usability concerns and providing support for training could enhance the acceptance and adoption of IFAS among coffee farmers. The findings on Ease of access to training suggest that respondents value access to readily available and accessible training resources for IFAS technology adoption. The high level of agreement regarding the comprehensiveness, accessibility, and sufficiency of training opportunities indicates a positive perception of the training infrastructure surrounding IFAS. These results underscore the importance of providing comprehensive and easily understandable training materials to facilitate effective learning and adoption of IFAS among coffee farmers. Moreover, ensuring the availability of sufficient training opportunities can further enhance the readiness of farmers to embrace IFAS technology in their farming practices.

### **Attitude Towards Use**

The findings regarding farmers' attitudes towards the use of IFAS technology in coffee farming are promising, with a majority expressing positive attitudes and enthusiasm towards its integration into their farming practices. Respondents perceive IFAS as a valuable tool that aligns with their goals and aspirations, offering excitement about its potential benefits and enthusiasm for exploring its possibilities. These results are consistent with studies highlighting the importance of farmers' attitudes as key determinants of technology adoption (Zulqarnain et al., 2020). A positive attitude towards technology adoption is often associated with increased willingness to explore new practices and technologies, which can facilitate the successful

integration of IFAS into coffee farming operations. The findings indicate a generally positive attitude among respondents towards the integration of IFAS technology into coffee farming practices. Farmers perceive IFAS as a valuable tool that aligns with their goals and aspirations, offering excitement about its potential benefits and enthusiasm for exploring its possibilities. These results underscore the importance of fostering a supportive environment for technology adoption and providing adequate training and support to empower farmers in utilizing IFAS effectively. By capitalizing on farmers' positive attitudes and enthusiasm, stakeholders can facilitate the successful implementation and uptake of IFAS technology in coffee farming communities.

### **Behavioural Intention to Use**

The findings reveal a strong intention among respondents to actively use IFAS technology in their daily coffee farming activities, driven by perceived benefits and a positive outlook towards long-term adoption. This intention to adopt new technology aligns with the Theory of Planned Behavior (Ajzen, 1991), which posits that behavioral intention is a key predictor of actual behavior. High levels of intention to use IFAS technology suggest a readiness among farmers to embrace technological innovations for improving their farming practices. However, while intention is a critical precursor to behavior, it does not always translate into actual usage (Englert et al., 2023).

The findings reveal a strong intention among respondents to actively use IFAS technology in their coffee farming activities, driven by perceived benefits and a positive outlook towards long-term adoption. This indicates a promising level of readiness among farmers to embrace technological innovations for improving their farming practices. Stakeholders and policymakers can leverage these positive intentions to develop tailored training programs and support mechanisms that facilitate the effective implementation and sustained usage of IFAS technology in coffee farming communities.

### **Actual Usage**

Despite positive attitudes and intentions towards adopting IFAS, there were low levels of current usage that suggest barriers to adoption or challenges in implementing the technology effectively. The discrepancy between intention and actual usage highlights the importance of addressing

practical concerns and barriers that hinder technology adoption in real-world contexts (Geng et al., 2023). Factors such as limited access to technology, inadequate training, and perceived usability issues may contribute to the gap between intention and usage among coffee farmers. Bridging this gap requires targeted interventions that address the specific needs and challenges faced by farmers in adopting and utilizing IFAS technology effectively. The findings reveal a notable inequality between the perceived importance of IFAS technology and its actual usage among coffee farmers. Despite positive attitudes and intentions towards adopting IFAS, the low levels of current usage suggest barriers to adoption or challenges in implementing the technology effectively. It is imperative for stakeholders and policymakers to identify and address the factors hindering the adoption and utilization of IFAS among coffee farmers. Strategies such as targeted training programs, improved access to technology, and tailored support mechanisms may be necessary to bridge the gap between intention and actual usage, thereby facilitating the integration of IFAS into coffee farming practices.

### **5.3 Contributions of the study**

The study's contribution to the existing body of knowledge in the field of agricultural technology adoption, particularly in the context of coffee farming in Western Uganda, is highlighted. This section discusses how the research fills gaps in literature, advances theoretical understanding, and provides practical insights for stakeholders.

#### **5.3.1 Contributions to the Body of Knowledge**

This study contributes valuable insights into the adoption and use of Intelligent Farm Advisory Systems (IFAS) technology in coffee farming communities. By exploring farmers' perceptions, attitudes, and intentions towards IFAS, the study enhances our understanding of technology adoption dynamics in agricultural contexts.

The research addresses knowledge gaps in the literature by examining the perceived usefulness, relevance, and usability of IFAS technology among coffee farmers. By providing empirical evidence on these aspects, the study contributes to filling existing gaps in understanding farmers' perspectives on technology adoption.

The study offers understanding of the socio-economic and environmental factors influencing technology adoption in coffee farming. By considering the specific context of Western Uganda,

the research sheds light on the unique challenges and opportunities associated with implementing IFAS technology in this region.

### **5.3.2 Contributions to Policy Makers**

**Informed Decision-Making:** The findings of this study can inform policy makers and agricultural stakeholders about the potential benefits and challenges of promoting IFAS adoption in coffee farming communities. Policy makers can use the insights to develop evidence-based policies and initiatives aimed at supporting technology adoption and enhancing agricultural productivity.

**Targeted Interventions:** Policy makers can design targeted interventions and support programs to address the identified barriers to IFAS adoption, such as access to training, usability concerns, and infrastructure limitations. By tailoring interventions to the specific needs of coffee farmers, policy makers can foster a conducive environment for technology uptake and utilization.

### **5.3.3 Contributions to Users**

**Empowerment through Technology:** Coffee farmers can benefit from the study findings by gaining insights into the potential advantages of adopting IFAS technology in their farming practices. The research empowers farmers to make informed decisions about integrating technology into their operations, thereby enhancing productivity, resilience, and sustainability.

**Access to Resources and Support:** The study highlights the importance of access to training, support, and user-friendly interfaces in facilitating technology adoption. By advocating for improved access to resources and support services, users can overcome barriers to technology adoption and maximize the benefits of IFAS in their farming activities.

**Capacity Building:** The study contributes to capacity building efforts by raising awareness about the role of technology in modernizing agricultural practices. By fostering a culture of innovation and technology adoption, the research encourages stakeholders to explore new approaches to enhancing agricultural productivity and sustainability.

Knowledge Sharing and Collaboration: The findings of the study can stimulate knowledge sharing and collaboration among researchers, practitioners, and policy makers in the fields of agriculture, technology, and rural development. By sharing insights and best practices, stakeholders can collectively work towards harnessing the potential of technology to address pressing challenges in the agricultural sector.

#### **5.4 Recommendations of the study**

- Participatory design of IFAS interfaces

Farmers should work closely with technology developers and designers to improve the user interface and functionality of IFAS platforms, making them more intuitive, user-friendly, and accessible to farmers with varying levels of digital literacy. Also conduct usability testing and gather feedback from end-users to identify and address usability issues and enhance the overall user experience.

- Promotion of Information Sharing and Knowledge Exchange

Facilitate platforms for information sharing and knowledge exchange among coffee farmers, extension agents, researchers, and technology developers to promote learning, collaboration, and innovation in agricultural practices. Establish farmer cooperatives or community-based organizations to facilitate peer-to-peer learning and collective decision-making on technology adoption and best practices in coffee farming.

- Support for Sustainable Agriculture Practices

Integrate environmental sustainability considerations into IFAS technology and training programs to promote practices that minimize environmental impact, conserve natural resources, and enhance ecosystem resilience. Provide incentives and support for farmers implementing sustainable agriculture practices, such as agroforestry, organic farming, and soil conservation, in conjunction with IFAS technology.

- Community Engagement and Empowerment

Foster community engagement and participation in decision-making processes related to technology adoption, project planning, user support services (e.g., troubleshooting) and resource allocation to ensure that interventions are responsive to local needs, priorities, and aspirations. Empower farmers to take ownership of IFAS technology and become active agents of change by involving them in project design, implementation, and evaluation at the grassroots level.

#### **5.4 Future work**

Suggestions for future research directions and areas for further exploration are outlined in this section. The following are the suggested future ventures;

- Longitudinal Studies; Conduct longitudinal studies to track the long-term impact of IFAS technology adoption on coffee farming productivity, income levels, and environmental sustainability over multiple cropping seasons.
- Technology Integration; Explore opportunities to integrate IFAS technology with other digital tools and platforms, such as mobile applications, remote sensing technology, and blockchain-based systems, to enhance data collection, analysis, and decision-making in coffee farming.
- Adaptation to Climate Change; Investigate the potential of IFAS technology to support climate change adaptation and resilience-building strategies in coffee farming, including early warning systems for extreme weather events, drought-resistant crop varieties, and soil conservation practices.

#### **5.5 Limitations of Study**

The study was limited to the western region of Uganda it can be carried out in other regions.

#### **5.6 conclusion of the study**

In conclusion, this study investigated the perceptions, attitudes, and intentions of coffee farmers towards the adoption and use of Intelligent Farm Advisory Systems (IFAS) technology in

Western Uganda. The findings shed light on various aspects of IFAS technology adoption, including perceived usefulness, relevance to coffee farming, trust in technology, environmental sustainability, ease of use, access to training, interface usability, attitude towards use, behavioural intention, and actual usage.

The results indicate that coffee farmers perceive IFAS technology as a valuable tool with the potential to enhance task efficiency, mitigate risks, address market challenges, improve productivity, and support sustainable farming practices. Despite positive attitudes and intentions towards IFAS adoption, actual usage remains limited, suggesting barriers to adoption and challenges in technology implementation. Furthermore, the study highlights the importance of addressing contextual factors, technological infrastructure, ethical considerations, and environmental implications in promoting IFAS technology adoption and sustainability in coffee farming communities.

In light of these findings, it is imperative for stakeholders, policymakers, researchers, and practitioners to collaborate in developing tailored interventions, capacity-building initiatives, and policy frameworks that facilitate the effective adoption, utilization, and integration of IFAS technology into coffee farming practices. By leveraging the insights gained from this study and addressing the identified limitations, stakeholders can work towards promoting sustainable agricultural development, enhancing farmer livelihoods, and fostering resilience in coffee farming communities. Ultimately, the successful integration of IFAS technology has the potential to transform agricultural systems, improve food security, and contribute to the sustainable development goals in Uganda and beyond.

## REFERENCES

- A. Abraham. (2016). Impact of Antestia bug ( Antestiopsis sp .) on Coffee ( Coffea arabica L .) Production and Quality. *Journal of Biology, Agriculture and Healthcare*, 6(21), 18–22.
- Abasimel, N. A. (2020). Determinants of Coffee Market Outlet Choice by Smallholder Farmers in Seka Chokorsa District, Jimma Zone, Ethiopia. *Journal of Poverty, Investment and Development*, 54, 20–32. <https://doi.org/10.7176/jpid/54-03>
- Abdullah, F. A., & Samah, B. A. (2013). Factors Impinging Farmers' Use of Agriculture Technology. *Asian Social Science*, 9, 120.
- Abioye, E. A., Hensel, O., Esau, T. J., Elijah, O., Abidin, M. S. Z., Ayobami, A. S., Yerima, O., & Nasirahmadi, A. (2022). Precision Irrigation Management Using Machine Learning and Digital Farming Solutions. *AgriEngineering*, 4(1), 70–103. <https://doi.org/10.3390/agriengineering4010006>
- ADE. (2009). *Evaluation of the implementation of the Farm Advisory System*. December, 213.
- Adelman, C. (1993). Kurt Lewin and the Origins of Action Research. *Educational Action Research*, 1(1), 7–24. <https://doi.org/10.1080/0965079930010102>
- AGRA. (2016). Going Beyond Demos to Transform African Agriculture: The Journey of AGRA's Soil Health Program. Nairobi, Kenya. In *Alliance for a Green Revolution in Africa*. (Issue October).
- Akhtar, M. I. (2016). *Research Design*.
- Alem, D. D. (2020). An Overview of Data Analysis and Interpretations in Research. *Inter. J. Acad. Res. Educ. Rev*, 8(1), 1–27. <https://doi.org/10.14662/IJARER2020.015>
- Ali, A. (2021). *Quantitative Data Analysis*. <https://doi.org/10.13140/RG.2.2.23322.36807>
- Ali, J. (2012). Factors Affecting the Adoption of Information and Communication Technologies (ICTs) for Farming Decisions. *Journal of Agricultural \& Food Information*, 13, 78–96.

- Altaf, L., Bhat, A. A., Bhat, B. P., Bhat, S. A., & Wani, S. A. (2023). + *Journal of Agriculture Indian and Allied Sciences STRATEGIES*. March.
- Alves, L. M., Fowler, H., de Jesus da Costa Barreto, N., & Llopart, M. (2021). Chapter 3 - Climate change and climate variability. In J. Rodrigo-Comino (Ed.), *Precipitation* (pp. 53–68). Elsevier. <https://doi.org/https://doi.org/10.1016/B978-0-12-822699-5.00003-3>
- Antti, A., Johansson, T., Motaroki, L., Minoia, P., & Pellikka, P. (2021). Constraints for adopting climate-smart agricultural practices among smallholder farmers in Southeast Kenya. *Agricultural Systems*, 194(January), 103284. <https://doi.org/10.1016/j.agsy.2021.103284>
- Babirukamu, C. (2023). *ENHANCING ICT BASED INNOVATIONS FOR AGRICULTURAL TRANSFORMATION: modernization of Agricultural Value Chains*. March.
- Baffes, J. (2006). Restructuring Uganda ' s Coffee Industry: Why Going Back to the Basics Matters. *World Bank Policy Research*, 1–28.
- Balasundram, S. K., Golhani, K., Shamshiri, R. R., & Vadamalai, G. (2020). Precision Agriculture Technologies for Management of Plant Diseases. In I. Ul Haq & S. Ijaz (Eds.), *Plant Disease Management Strategies for Sustainable Agriculture through Traditional and Modern Approaches* (pp. 259–278). Springer International Publishing. [https://doi.org/10.1007/978-3-030-35955-3\\_13](https://doi.org/10.1007/978-3-030-35955-3_13)
- Baskerville, R., Ga, A., Pries-heje, J., & Venable, J. (2009). Soft Design Science Methodology. *ResearchGate*. <https://doi.org/10.1145/1555619.1555631>
- Ben, E., Nelson, K., & Kaazara, A. G. (2023). *FACTORS INFLUENCING COFFEE PRODUCTION AMONG SMALL SCALE FARMERS IN UGANDA, A CASE STUDY OF BULEGENI SUBCOUNTY BULAMBULI*. June.
- Bezabh, A. (2016). *Adoption Study of Coffee Production Technologies in South West*. 50, 13–20.
- Bidarbakhtnia, A. (2020). *Surveys Under Lockdown; a pandemic lesson*. 23.
- Bilen, C., Chami, D. El, Mereu, V., Trabucco, A., Marras, S., & Spano, D. (2023). *A Systematic Review on the Impacts of Climate Change on*. 1–20.

- Birhan, M. (2023). A Case Study of the Management Information System in the Coffee Industry in SW Ethiopia. *Qeios*, 1–7.
- Bobryk, C. W., Yost, M. A., & Kitchen, N. R. (2018). Field variability and vulnerability index to identify regional precision agriculture opportunity. *Precision Agriculture*, 19(4), 589–605. <https://doi.org/10.1007/s11119-017-9541-6>
- Bogdanovski, O. P., Svenningsson, C., Månsson, S., Oxenstierna, A., & Sopasakis, A. (2023). Yield Prediction for Winter Wheat with Machine Learning Models Using Sentinel-1, Topography, and Weather Data. *Agriculture (Switzerland)*, 13(4), 1–19. <https://doi.org/10.3390/agriculture13040813>
- Borrella, I., Mataix, C., & Carrasco-Gallego, R. (2015). Smallholder Farmers in the Speciality Coffee Industry: Opportunities, Constraints and the Businesses that are Making it Possible. *IDS Bulletin*, 46(3), 29–44. <https://doi.org/10.1111/1759-5436.12142>
- Brenes, J. A., Eger, M., & Marín-Raventós, G. (2021). Early Detection of Diseases in Precision Agriculture Processes Supported by Technology. In A. Joshi, A. K. Nagar, & G. Marín-Raventós (Eds.), *Sustainable Intelligent Systems* (pp. 11–33). Springer Singapore. [https://doi.org/10.1007/978-981-33-4901-8\\_2](https://doi.org/10.1007/978-981-33-4901-8_2)
- Carneiro, A. L. C., Silva, L. de B., & Faulin, M. S. A. R. (2021). *Artificial intelligence for detection and quantification of rust and leaf miner in coffee crop*. 1–10.
- Cerda, R., Avelino, J., Gary, C., Tixier, P., Lechevallier, E., & Allinne, C. (2017). Primary and secondary yield losses caused by pests and diseases: Assessment and modeling in coffee. *PLoS ONE*, 12(1), 1–17. <https://doi.org/10.1371/journal.pone.0169133>
- Chadwick, A. E. (2017). The SAGE Encyclopedia of Communication Research Methods. *The SAGE Encyclopedia of Communication Research Methods*. <https://doi.org/10.4135/9781483381411>
- Chavas, J., & Nauges, C. (2020). Uncertainty, Learning, and Technology Adoption in Agriculture. *Applied Economic Perspectives and Policy*, 42, 42–53.
- Chen, L., Chen, Z., Zhang, Y., Liu, Y., Osman, A. I., Farghali, M., Hua, J., Al-Fatesh, A., Ihara, I., Rooney, D. W., & Yap, P. S. (2023). Artificial intelligence-based solutions for climate change: a

- review. In *Environmental Chemistry Letters* (Vol. 21, Issue 5). Springer International Publishing. <https://doi.org/10.1007/s10311-023-01617-y>
- Che'ya, N. N., Mohidem, N. A., Roslin, N. A., Saberioon, M., Tarmidi, M. Z., Arif Shah, J., Fazlil Ilahi, W. F., & Man, N. (2022). Mobile Computing for Pest and Disease Management Using Spectral Signature Analysis: A Review. *Agronomy*, *12*(4), 1–22. <https://doi.org/10.3390/agronomy12040967>
- Chi, T. T. N., & Yamada, R. (2005). *Factors affecting farmers ' adoption of technologies in farming system : A case study in OMon district , Can Tho province , Mekong Delta .*
- Coombs Hayden. (2022). *CaseStudiesDefined.*
- Davis, A. P., Kiwuka, C., Faruk, A., Mulumba, J., & Kalema, J. (2022a). A review of the indigenous coffee resources of Uganda and their potential for coffee sector sustainability and development. *Frontiers in Plant Science*, *13*(February), 1–16. <https://doi.org/10.3389/fpls.2022.1057317>
- Davis, A. P., Kiwuka, C., Faruk, A., Mulumba, J., & Kalema, J. (2022b). A review of the indigenous coffee resources of Uganda and their potential for coffee sector sustainability and development. *Frontiers in Plant Science*, *13*, 1057317. <https://doi.org/10.3389/FPLS.2022.1057317/BIBTEX>
- Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. *Management Science*, *35*, 982–1003.
- Davison, L. (2022). *Uganda Coffee Production and Sourcing Guide.*
- Dissanayake, C. A. K., Jayathilake, W., Wickramasuriya, H. V. A., Dissanayake, U., Kopyawattage, K. P. P., & Wasala, W. M. C. B. (2022). Theories and Models of Technology Adoption in Agricultural Sector. *Human Behavior and Emerging Technologies*, *2022*, 9258317. <https://doi.org/10.1155/2022/9258317>
- Eastwood, C., Ayre, M., Nettle, R., & Dela Rue, B. (2019). Making sense in the cloud: Farm advisory services in a smart farming future. *NJAS - Wageningen Journal of Life Sciences*, *90–91*(December 2018), 100298. <https://doi.org/10.1016/j.njas.2019.04.004>

- Eron, F., Noman, M., de Oliveira, R. R., Marques, D. de S., Durelli, R. S., Freire, A. P., & Junior, A. C. (2023). *Computer Vision-Aided Intelligent Monitoring of Coffee: Towards Sustainable Coffee Production*.
- Evangelopoulos, N., Sidorova, A., & Riolli, L. T. (2003). *Can Service-Learning Help Students Appreciate an Unpopular Course? A Theoretical Framework Analysis of Social Media View project Theoretical Contributions to Latent Semantic Analysis (LSA) View project*. June 2014.
- Friyadie, F., & Muharam, F. (2023). Electronic Receipt of Document Control System using Technology Acceptance Model. *JURIKOM (Jurnal Riset Komputer)*, 10(2), 519. <https://doi.org/10.30865/jurikom.v10i2.6027>
- Gebre, E. (2020). Factors Affecting Coffee Market Supply of Smallholder Farm Household: The Case of Gewata District Kaffa Zone, Southwest Ethiopia. *International Journal of Economics and Financial Research*, 6(62), 14–21. <https://doi.org/10.32861/ijefr.62.14.21>
- Giraldo, P. J. R., Aguirre, Á. G., Muñoz, C. M., Prieto, F. A., & Oliveros, C. E. (2017). Sensor fusion of a mobile device to control and acquire videos or images of coffee branches and for georeferencing trees. *Sensors (Switzerland)*, 17(4), 1–23. <https://doi.org/10.3390/s17040786>
- Goundar, S. (2012). *Chapter 3-Research Methodology and Research Method*. <https://www.researchgate.net/publication/333015026>
- Grant, C., & Osanloo, A. (2014). *Understanding, selecting, and integrating a Theoretical framework in dissertation research:Creating the blueprint for your “house.”* 12–26. <https://doi.org/10.5929/2014.4.2.9>
- Groenen, D. (2018). The Effects of Climate Change on the Pests and Diseases of Coffee Crops in Mesoamerica. *Journal of Climatology & Weather Forecasting*, 06(03). <https://doi.org/10.4172/2332-2594.1000239>
- Harrell, M. C., & Bradley, M. A. (2009). *Data Collection Methods: Semi-Structured Interviews and Focus Groups*. [www.rand.org](http://www.rand.org)
- House, C. (2024). *Coffee sub-sector strategy (2020/21 – 2024/25)*.

- (ICO), I. C. O. (2022). Exports by exporting countries to all destinations January 2022. *Monthly Trade Statistics, 2022*(January), 1.
- Javaid, M., Haleem, A., Khan, I. H., & Suman, R. (2023). Understanding the potential applications of Artificial Intelligence in Agriculture Sector. *Advanced Agrochem, 2*(1), 15–30. <https://doi.org/10.1016/j.aac.2022.10.001>
- Javaid, M., Haleem, A., Singh, R. P., & Suman, R. (2022a). Enhancing smart farming through the applications of Agriculture 4.0 technologies. *International Journal of Intelligent Networks, 3*(October), 150–164. <https://doi.org/10.1016/j.ijin.2022.09.004>
- Javaid, M., Haleem, A., Singh, R. P., & Suman, R. (2022b). International Journal of Intelligent Networks Enhancing smart farming through the applications of Agriculture 4 . 0 technologies. *International Journal of Intelligent Networks, 3*(July), 150–164. <https://doi.org/10.1016/j.ijin.2022.09.004>
- Karthikeyan, S., & Pandian, M. S. (2021). Science and Technology in the Modern Agricultural Sector: An Overview. *International Journal of Advanced Research in Science, Communication and Technology*.
- Kasim, K. (2016). *Exploring Agricultural Innovation Processes among Actors in Coffee Farming Sector in Eastern Ethiopia. 25*, 1–12.
- Khan, N., Ray, R. L., Sargani, G. R., Ihtisham, M., Khayyam, M., & Ismail, S. (2021). Current progress and future prospects of agriculture technology: Gateway to sustainable agriculture. *Sustainability (Switzerland), 13*(9), 1–31. <https://doi.org/10.3390/su13094883>
- Kirkpatrick, K. (2019). Technologizing agriculture. *Communications of the ACM, 62*(2), 14–16. <https://doi.org/10.1145/3297805>
- Kittichotsatsawat, Y., Jangkrajarn, V., & Tippayawong, K. Y. (2021). Enhancing coffee supply chain towards sustainable growth with big data and modern agricultural technologies. *Sustainability (Switzerland), 13*(8), 1–20. <https://doi.org/10.3390/su13084593>
- Le, Q. V., Cowal, S., Jovanovic, G., & Le, D.-T. (2021). A Study of Regenerative Farming Practices and Sustainable Coffee of Ethnic Minorities Farmers in the Central Highlands of Vietnam. *Frontiers in Sustainable Food Systems, 5*. <https://doi.org/10.3389/fsufs.2021.712733>

- Lekshmi, G., & Rekha, P. (2022). AI Based IoT Framework for Soil Analysis and Fertilization Recommendation for Smart Coconut Farming. *2022 8th International Conference on Signal Processing and Communication (ICSC)*, 26–31. <https://doi.org/10.1109/ICSC56524.2022.10009026>
- Luzinda, H. (2018). Factors Influencing Adoption of Improved Robusta Coffee Technologies in Uganda. *Uganda Journal of Agricultural Sciences*, 18(1), 33–41. <https://doi.org/10.4314/ujas.v18i1.3>
- Luzinda, H., Nelima, M., Wabomba, A., Musoli, A., & Kakuru, A. (2018). Factors Influencing Adoption of Improved Robusta Coffee Technologies in Uganda. *Uganda Journal of Agricultural Sciences*, 18(1), 33–41. <https://doi.org/10.4314/ujas.v18i1.3>
- Ma, Q., & Liu, L. (2005). The Technology Acceptance Model: A Meta-Analysis of Empirical Findings. *Advanced Topics in End User Computing, Volume 4, January*. <https://doi.org/10.4018/9781591404743.ch006.ch000>
- MAAIF, & UCDA. (2022). *Coffee and Cocoa Value Chains Development in Uganda*. [www.ugandacoffee.go.ug](http://www.ugandacoffee.go.ug)
- Malhi, G. S., Kaur, M., & Kaushik, P. (2021). Impact of climate change on agriculture and its mitigation strategies: A review. *Sustainability (Switzerland)*, 13(3), 1–21. <https://doi.org/10.3390/su13031318>
- Mbowa, S., Odokonyero, T., Muhumuza, T., & Munyambonera, E. (2017). Does coffee production reduce poverty? Evidence from Uganda. *Journal of Agribusiness in Developing and Emerging Economies*, 7(3), 260–274. <https://doi.org/10.1108/JADEE-01-2016-0004>
- Miao, R., & Khanna, M. (2020). Harnessing advances in agricultural technologies to optimize resource utilization in the food-energy-water nexus. *Annual Review of Resource Economics*, 12, 65–85. <https://doi.org/10.1146/annurev-resource-110319-115428>
- Mishra, A. K., proposeiams, R. P., & Detre, J. D. (2009). Internet Access and Internet Purchasing Patterns of Farm Households. *Agricultural and Resource Economics Review*, 38(2), 240–257. <https://doi.org/10.1017/S1068280500003233>

- Morgan, D. L., & Spanish, M. T. (1984). Focus groups: A new tool for qualitative research. *Qualitative Sociology*, 7(3), 253–270. <https://doi.org/10.1007/BF00987314>
- MSUYA, A. M., & MAHONGE, C. P. (2022). Impact of climate variability, farmers adaptation and coping strategies on coffee production in highlands of Kigoma District, Tanzania. *Asian Journal of Forestry*, 6(1), 34–42. <https://doi.org/10.13057/asianjfor/r060105>
- Muhammad, S., & Kabir, S. (2016). *METHODS OF DATA COLLECTION Article View project*. <https://www.researchgate.net/publication/325846997>
- Mulyono, A. E., Apnitami, P., Wangi, I. S., Wicaksono, K. N. P., & Apriono, C. (2022). The Potential of Smart Farming IoT Implementation for Coffee farming in Indonesia: A Systematic Review. *Green Intelligent Systems and Applications*, 2(2), 53–70. <https://doi.org/10.53623/gisa.v2i2.95>
- Mwangi, M., & Kariuki, S. (2015). Factors Determining Adoption of New Agricultural Technology by Smallholder Farmers in Developing Countries. *Journal of Economics and Sustainable Development*, 6, 208–216.
- Nabaasa, E., Kalibwani, R. M., Ssemakula, E., & Mujuni, B. (2022). *Institutional Factors and Technology Adoption amongst Small- holder Coffee Farmers in Kanungu District South-Western Uganda. April*. <https://doi.org/10.20944/preprints202204.0145.v1>
- Naik, B. J., Kim, S. C., Seenaiyah, R., Basha, P. A., & Song, E. Y. (2021). Coffee cultivation techniques, impact of climate change on coffee production, role of nanoparticles and molecular markers in coffee crop improvement, and challenges. *Journal of Plant Biotechnology*, 48(4), 207–222. <https://doi.org/10.5010/JPB.2021.48.4.207>
- OECD. (2021). Adoption of Technologies for Sustainable Farming Systems. *Wageningen Workshop Proceedings*, 149.
- P, Divyashri., Pinto, L. A., Mary, L., P, Manasa., & Dass, S. (2021). The Real-Time Mobile Application for Identification of Diseases in Coffee Leaves using the CNN Model. *2021 Second International Conference on Electronics and Sustainable Communication Systems (ICESC)*, 1694–1700. <https://doi.org/10.1109/ICESC51422.2021.9532662>

- Panggabean, Y. B. S., Arsyad, M., Mahyuddin, & Nasaruddin. (2021). Coffee farming business development: E-commerce technology utilization. *IOP Conference Series: Earth and Environmental Science*, 807(3), 32011. <https://doi.org/10.1088/1755-1315/807/3/032011>
- Paquin, P. (2009). Functional and speciality beverage technology. In *Functional and Speciality Beverage Technology*. <https://doi.org/10.1533/9781845695569>
- Policy, N. C. (2018). National Coffee Policy. *National Coffee Policy*, 02.
- Qureshi, A., Kumar, A., & Lal Nag, J. (2018). Precision Agriculture and Carbon Sequestration - Need of an Hour in Current Climate Changing Scenario. *International Journal of Current Microbiology and Applied Sciences*, 7(2), 1668–1673. <https://doi.org/10.20546/ijcmas.2018.702.202>
- Rao, K., Murthy, K. D., Dhulipala, R., Gupta, M., Sreepada, S., & Whitbread, A. (2019). *Delivering climate risk information to farmers at scale : the Intelligent agricultural Systems Advisory Tool ( ISAT )*.
- Redden, J. (2022). Coffee in the Global Economy. *Perspectives on Global Development and Technology*, 20(5–6), 558–567. <https://doi.org/https://doi.org/10.1163/15691497-12341612>
- Ribeyre, F., & Avelino, J. (2012). Impact of Field Pests and. *Specialty Coffee: Managing Quality*, January, 151–176.
- Ristaino, J. B., Anderson, P. K., Bebber, D. P., Brauman, K. A., Cunniffe, N. J., Fedoroff, N. V., Finegold, C., Garrett, K. A., Gilligan, C. A., Jones, C. M., Martin, M. D., MacDonald, G. K., Neenan, P., Records, A., Schmale, D. G., Tateosian, L., & Wei, Q. (2021). The persistent threat of emerging plant disease pandemics to global food security. *Proceedings of the National Academy of Sciences of the United States of America*, 118(23), 1–9. <https://doi.org/10.1073/pnas.2022239118>
- Rodríguez, J. P., Montoya-Munoz, A. I., Rodriguez-Pabon, C., Hoyos, J., & Corrales, J. C. (2021). IoT-Agro: A smart farming system to Colombian coffee farms. *Computers and Electronics in Agriculture*, 190, 106442. <https://doi.org/https://doi.org/10.1016/j.compag.2021.106442>
- Ronalds, A. J., David, O., & Opio, F. (2023). Socioeconomic Factors Influencing Uptake of Coffee Production Recommended Practices in Kichwamba and Kirugu Sub-Counties Rubirizi District,

- Uganda. *East African Journal of Agriculture and Biotechnology*, 6(1), 1–20.  
<https://doi.org/10.37284/eajab.6.1.1069>
- Rubongoya, R. (2019). *Evaluating the Utilisation of Climate-Smart Agricultural Technologies By Smallholder Farmers : a Case in Kyenjojo District , Uganda.*
- Rwamigisa, P. B. (2019). *Agriculture in Uganda : Performance and policy implementation. August, 1–27.*
- Sahu, B., Chatterjee, S., Mukherjee, S., Sharma, C., & Author, C. (2019). Tools of precision agriculture: A review. ~ 2692 ~ *International Journal of Chemical Studies*, 7(6), 2692–2697.
- Sebsibie, S., Ketema, D. M., & Abate, G. T. (2023). *Digital farmer registry and tailored extension and advisory services in Ethiopia : A process evaluation. February.*
- Setia, M. S. (2016). Methodology series module 3: Cross-sectional studies. *Indian Journal of Dermatology*, 61(3), 261–264. <https://doi.org/10.4103/0019-5154.182410>
- Shanmugam, K. (2023). Using the Technology Acceptance Model To Predict Lecturers' Acceptance of Augmented Reality Notes. *Docens Series in Education*, 4(August 2022), 44–61. <https://doi.org/10.20319/dv4.4461>
- Sharma, Dr. R., Mishra, V., & Srivastava, S. (2023). Enhancing Crop Yields through IoT-Enabled Precision Agriculture. *2023 International Conference on Disruptive Technologies (ICDT)*, 279–283. <https://doi.org/10.1109/ICDT57929.2023.10151422>
- Sharma, S., & Srushtideep, A. (2022). Precision Agriculture and Its Future. *International Journal of Plant & Soil Science*, 34(24), 200–204. <https://doi.org/10.9734/ijpss/2022/v34i242630>
- Shevelov, A. (2021). *Impact of Digital Transformation on Uganda' s agriculture and its participants. February, 38.*
- Siddiqua, A., Kabir, M. A., Ferdous, T., Ali, I. B., & Weston, L. A. (2022). Evaluating Plant Disease Detection Mobile Applications: Quality and Limitations. *Agronomy*, 12(8). <https://doi.org/10.3390/agronomy12081869>
- Silva, J., Varela, N., & Lezama, O. B. P. (2021). Multispectral Image Analysis for the Detection of Diseases in Coffee Production. In Y. Dong, E. Herrera-Viedma, K. Matsui, S. Omatsu, A.

- González Briones, & S. Rodríguez González (Eds.), *Distributed Computing and Artificial Intelligence, 17th International Conference* (pp. 198–205). Springer International Publishing.
- Silva, P. (2015). *Davis' Technology Acceptance Model (TAM) (1989)*.
- Sophia Hartatri, D. F., & Neilson, J. (2021). Livelihood strategies of smallholder coffee farmers: case study in Simalungun, North Sumatera. *E3S Web of Conferences*, 306, 1–9. <https://doi.org/10.1051/e3sconf/202130602051>
- Sørensen, C. A. G., Kateris, D., & Bochtis, D. (2019a). ICT Innovations and Smart Farming. In M. Salampasis & T. Bournaris (Eds.), *Information and Communication Technologies in Modern Agricultural Development* (pp. 1–19). Springer International Publishing.
- Sørensen, C. A. G., Kateris, D., & Bochtis, D. (2019b). ICT Innovations and Smart Farming. In M. Salampasis & T. Bournaris (Eds.), *Information and Communication Technologies in Modern Agricultural Development* (pp. 1–19). Springer International Publishing.
- Sousa, J. S., Neves, J. C. L., Martinez, H. E. P., & Alvarez, V. H. V. (2018). Relationship between Coffee Leaf Analysis and Soil Chemical Analysis. *Revista Brasileira de Ciência Do Solo*, 42, e0170109. <https://doi.org/10.1590/18069657rbc20170109>
- Stringer, L. C., Fraser, E. D. G., Harris, D., Lyon, C., Pereira, L., Ward, C. F. M., & Simelton, E. (2020). Adaptation and development pathways for different types of farmers. *Environmental Science and Policy*, 104(April 2019), 174–189. <https://doi.org/10.1016/j.envsci.2019.10.007>
- Surabhi, S., Avinash, S. S., & Sumit, K. S. (2022). Role of technology in advancing agriculture in a digital world. *I-Manager's Journal on Information Technology*.
- Swaibu, M., Tonny, O., & Ezra, M. (2014). *Coffee Production in mid-Northern Uganda: Prospects and Challenges*.
- Tadesse, T., Tesfaye, B., & Abera, G. (2020). Coffee production constraints and opportunities at major growing districts of southern Ethiopia. *Cogent Food and Agriculture*, 6(1). <https://doi.org/10.1080/23311932.2020.1741982>
- Tajik, O., & Golzar, J. (2022). *Simple Random Sampling*. <https://doi.org/10.22034/ijels.2022.162982>

- Talaviya, T., Shah, D., Patel, N., Yagnik, H., & Shah, M. (2020). Implementation of artificial intelligence in agriculture for optimisation of irrigation and application of pesticides and herbicides. *Artificial Intelligence in Agriculture*, 4, 58–73. <https://doi.org/10.1016/j.aiaa.2020.04.002>
- Tariku Olana Jawo, D. K., & Lojka, B. (2023). The impact of climate change on coffee production of small farmers and their adaptation strategies: a review. *Climate and Development*, 15(2), 93–109. <https://doi.org/10.1080/17565529.2022.2057906>
- Thorat, T., Patle, B. K., & Kashyap, S. K. (2023). Intelligent insecticide and fertilizer recommendation system based on TPF-CNN for smart farming. *Smart Agricultural Technology*, 3(June 2022), 100114. <https://doi.org/10.1016/j.atech.2022.100114>
- Tripp, D. (2005). *Action research: a methodological introduction*. <https://www.researchgate.net/publication/237316452>
- UCDA. (2019). *Robusta coffee handbook: A sustainable coffee industry with high stakeholder value for social economic transformation*. 148.
- UCDA. (2021). *Sustainable Industrialization, value addition for inclusive growth, Employment and Sustainable Wealth creation*.
- UCDA. (2023). *Report CY 2022/23 Issue 4. JANUARY*.
- UCDA, U. C. D. A. (2023). *UGANDA COFFEE PROFILES*. [https://ugandacoffee.go.ug/sites/default/files/Uganda\\_Coffee\\_Profiles.pdf](https://ugandacoffee.go.ug/sites/default/files/Uganda_Coffee_Profiles.pdf)
- Venkatesh, V., & Davis, F. D. (1996). A Model of the Antecedents of Perceived Ease of Use: Development and Test†. *Decision Sciences*, 27, 451–481.
- Venkatesh, V., & Davis, F. D. (2000). Theoretical extension of the Technology Acceptance Model: Four longitudinal field studies. *Management Science*, 46(2), 186–204. <https://doi.org/10.1287/mnsc.46.2.186.11926>
- Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User Acceptance of Information Technology: Toward a Unified View. *International Encyclopedia of Ergonomics and Human*

*Factors, Second Edition - 3 Volume Set*, 27(3), 425–478.  
<https://doi.org/10.1201/9780849375477.ch230>

Wahyudi, J. (2023). The acceptance of a smartphone application for disaster: Technology acceptance model approach. *IOP Conference Series: Earth and Environmental Science*, 1180(1).  
<https://doi.org/10.1088/1755-1315/1180/1/012002>

Wambua, D. M., Gichimu, B. M., & Ndirangu, S. N. (2021). Smallholder Coffee Productivity as Affected by Socioeconomic Factors and Technology Adoption. *International Journal of Agronomy*, 2021. <https://doi.org/10.1155/2021/8852371>

WATSON, K., & ACHINELLI, M. L. (2008). Context and contingency: the coffee crisis for conventional small-scale coffee farmers in Brazil. *The Geographical Journal*, 174(3), 223–234.  
<https://doi.org/https://doi.org/10.1111/j.1475-4959.2008.00277.x>

Winter, E., Marton, S. M. R. R., Baumgart, L., Curran, M., Stolze, M., & Schader, C. (2020). Evaluating the Sustainability Performance of Typical Conventional and Certified Coffee Production Systems in Brazil and Ethiopia Based on Expert Judgements. *Frontiers in Sustainable Food Systems*, 4(May), 1–18. <https://doi.org/10.3389/fsufs.2020.00049>

You, L., & Bolwig, S. (2020). *Alternative Growth Scenarios for Ugandan Coffee to 2020 ALTERNATIVE GROWTH SCENARIOS FOR UGANDAN COFFEE TO 2020 Liangzhi You and Simon Bolwig Environment and Production Technology Division International Food Policy Research Institute. February 2003.*



# UGANDA CHRISTIAN UNIVERSITY

A Centre of Excellence in the Heart of Africa

## SCHOOL OF RESEARCH & POSTGRADUATE STUDIES DISSERTATION CORRECTION COMPLIANCE FORM (POST VIVA FORM)

Date: 21/05/2024

Name of Candidate: Byaruhanga Benson Mworozu

Reg.No: KS22M10/007

Title of Dissertation: A FRAMEWORK FOR THE ADOPTION OF INTELLIGENT FARM ADVISORY SYSTEMS FOR THE COFFEE SECTOR: A CASE OF WESTERN UGANDA

S/N	COMMENTS BY EXTERNAL EXAMINER	ACTION TAKEN	INDICATOR
1	The description of methodology does not explicitly show how research questions are mapped to the results and at what stage in the research design - if the study is to be repeatable. The methodology does not show how the proposed framework is derived	Design Science Cycle was employed to help the researcher achieve objectives one and two. In the Relevance cycle the researcher reviewed on the factors influencing the adoption of technology in coffee production in Western Uganda including challenges faced in the adoption of IFAS in Uganda as presented in chapter two. In the Design cycle, the study was able after comparison of existing adoption models to adopt an existing model, TAM and added on other constructs based on the requirements gathered in chapter 2 to come up with a conceptual framework to guide the study.	Chapter 2 Table 2.1 Comparison of Adoption models on page 22 and figure 2.5 as conceptual framework on page.  Chapter 3 Figure 3.1 Design Science cycle on page 32 corrected
2	The results as presented in chapter 4 are not aligned to corresponding objectives.	Section 4.5 presents results of objective two Section 4.6 presents results of Objective three	Chapter 4 Pages 41-54 and 54-64 corrected
3	The framework is not clearly	Framework clearly presented in figure 4.11	Chapter 4 page

	presented.		55 corrected3
4	The validation of the framework is not provided for. There is need for standalone sections providing for each result.	Partial Least Squares structured equation modeling using smartPLS was used to test the framework and sections and their corresponding figures and tables from 4.6-4.10 are all dedicated to display the results of the test.	Chapter 4 Pages 54-64 corrected
5	There are no conclusions explicitly stated corresponding to the results for each objective.	The conclusions are provided in chapter 4 section 4.14	Chapter 4 pages 65-66

S/N	COMMENTS BY INTERNAL EXAMINER	ACTION TAKEN	INDICATOR
1	How do constructs relate with others and the results of the hypothesis stated in the conceptual framework need to be seen	A correlation matrix was used to identify significant relationships between the constructs within the conceptual framework. Also, hypothesis testing conducted and significant results revealed.	Correlation matrix in Table 4.4 at page 56 and Hypothesis testing in Table 4.10 on page 62
2	Carry out quality checks on the questionnaire and present results of your analysis	Cronbach Alpha Coefficient was used to conduct Validity and Reliability checks on the questionnaire.	Table 3 on Page 39, corrected
3			

S/N	COMMENTS BY VIVA VOCE PANNEL	ACTION TAKEN	INDICATOR
1	Specific objectives and research questions need to be synchronized	Research questions modified to align with the Research objectives	Page 5, corrected
2	The actual developed framework integrating the variables from the field should be shown	The actual framework was developed and presented in figure 18	Figure 18 on page 56 corrected
3	The framework should be tested and validated and the results (whether it works as shown).	Frame work was tested and results revealed significant findings.	The results are shown in figures 17 and 18 on page 56
4	The dependent and independent variables should be indicated and the results/ findings from the research could be better represented using a correlation matrix instead of tabular form.	Path coefficient matrix and figure 17 used to represent the dependent and independent valuables.  The Correlation matrix was used to present the findings from research	Table 9 on page 59 indicates the Path coefficient matrix and figure 17 showing model design 1 at page 56

			The correlation matrix is represented in Table 5 at page 56.
5	Significance levels from the correlation results should be clearly indicated, the negative values explained clearly and the R squared values rechecked especially the unusual ones like 0.9612 and 0.9417	Significance levels clearly indicated in figure 18 and Table 18. P values and T statistics show the significance of the relationships. Also, the R squared values rechecked.	Pages 57, 58, 59 and 60 corrected

Candidate's Name Byaruhanga Benson Mworozzi

Signature



Supervisor's Name Justine Mukalere

Signature



**NB: Post Viva compliance form is designed to capture all the corrections recommended by internal examiner (supervisor), external examiner and viva panel.**