AGRICULTURAL TECHNOLOGY ADOPTION AMONG SMALLHOLDER COMMERCIAL FARMERS IN RURAL GHANA: A CONSUMER BEHAVIOUR PERSPECTIVE

by

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DECLARATION

I, Faustin Apeletey Adokou, Passport Number ###### and Student Number ########, do hereby declare that this research project submitted to the Central University of Technology, Free State for the Degree Doctor of Philosophy in Management Science (Marketing) is my own independent work; and complies with the Code of Academic Integrity, as well as other relevant policies, procedures, rules and regulations of the Central University of Technology, Free State; and has not been submitted before to any institution by myself or any other person in fulfilment (or partial fulfilment) of the requirements for the attainment of any qualification.

Signature of Student: Date: 26/06/2024

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This thesis is dedicated to my family for their support and encouragement.

ABSTRACT

Through the behavioural perspectives of smallholder farmers, the adoption of agricultural technology is examined to understand opportunities for sustainable food production and develop a strategy for technology adoption. The general food insecurity, hunger, and poverty among rural farmers are problems facing Ghana's agricultural sector. The government launched several agricultural development programs to solve these issues, but did not have the desired impact. Despite the significant advantages of using modern agricultural technology to boost food production, reduce hunger and poverty, and increase incomes for struggling rural farmers, adoption rates among farmers are low. This study uses a marketing approach to help farmers understand the dynamics of adopting agricultural technology. A survey method was utilised to collect data from 285 randomly selected respondents who are smallholder rice farmers in the Volta Region of Ghana. The data received were analysed using Structural Equation Modelling (SEM) to understand the relationship and correlation between the measured consumer behaviour variables: Psychological, Personal, Social, and technology adoption patterns. The finding showed a 95% positive relationship between technology adoption and perceived usefulness and other positive correlation records in the SEM analysis.

The study opined that increased technology adoption would be achieved by applying a technology adoption strategy that partners with farmers to accommodate their input in designing and deploying agricultural technology. The work presented here is based on evidence that consumer behaviour regarding technology adoption is essential, and a strategy is presented to guide future technology adoption patterns amongst smallholder farmers in Ghana, Volta Region. The study also revealed that though there are several frameworks to support farmers' adoption of agricultural technology, some academics have begun to see the role of marketing strategy as inherently linked with consumer behaviour and technology adoption to achieve sustainable food production.

This study shows numerous opportunities exist for manufacturers of agricultural technology to partner with a farmer to produce technology that increases the adoption rate and establishes consumer behaviour strategy to leverage the benefit of technology for sustainable food production and the partnering opportunities. The results suggest that the government should implement a strategy framework to give agricultural industry stakeholders a focal point, encourage farmers to adopt agricultural technology, and ensure that every part works toward the same goal.

Keywords: Consumer behaviour, technology adoption, Volta Region, Ghana, marketing management, and adoption strategy.

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CHAPTER ONE

INTRODUCTION TO THE STUDY

1.1 INTRODUCTION

Improved adoption of agricultural technology is contrived by a limited understanding of elements of consumer behaviour to a consideration of the need for food security, poverty eradication, and government incentives to farmers (Mellon–Bedi, Descheemaeker, Hundie–Kotu, Frimpong & Groot, 2020). Understanding consumer behaviour's perspective is a necessary anchor for agricultural technology adoption. This is due to consumer behaviour patterns ingrained in the adoption process (Bhardwaj, 2020). This study examined the consumer behaviour perspective as inherently psychological, using the scope of psychological theories in consumer behaviour literature to develop an agricultural technology adoption strategy for smallholder commercial farmers in Ghana.

For smallholder commercial farmers in Ghana, a technology adoption that leverages consumer behaviour strategy to balance the desire for improved agricultural productivity, wealth, and access to much–needed government agricultural incentives and the capability of modern agricultural technology is critical. This study significantly contributes to the UN's Sustainable Development Goals (SDGs) to eradicate poverty (SDG1). Since 189 nations unanimously adopted the Millennium Declaration in September 2000, vowing to use every means possible to free people from severe poverty's dreadful and dehumanising conditions, poverty has remained a goal of the UN's Sustainable Development Goals. SDG1 aims to eliminate severe poverty for all people worldwide, cut the percentage of men, women, and children of all ages living in poverty by at least half, and put in place suitable social safety systems and measures for everyone. If there are ways to increase the application of agricultural technology in farming operations in order to increase output, the poverty of many rural farming opponents can undoubtedly be decreased (UN SDGs, 2015).

Food security is another Sustainable Development Goal of the UN that can be attained through this study (SDG2). A world free of hunger by 2030 is the second goal on the UN's list of Sustainable Development Goals. People who experience food insecurity and hunger have been increasing over time. According to estimates, between 720 million and 811 million people globally experienced hunger in 2020, an increase of roughly 161 million over the previous year. According to the estimate, 30% of the world's population—or roughly 2.4 billion people—were moderately or severely food insecure in 2020. This is because they do not regularly have access to enough food (The Sustainable Development Goals Report, 2022). Adopting agricultural technology to enhance agricultural outputs is a positive step in meeting the UN's goal of ending world hunger.

This research intends to contribute to achieving the eighth Sustainable Development Goal of the UN, which is to achieve reduced inequality and economic growth (SDG8) by 2030 to change our planet (UN SDGs, 2015). This objective acknowledges the significance of strong economic productivity and long-term economic growth for creating high–quality jobs. SDG8 aims to increase economic productivity and resource efficiency worldwide in both consumption and production and work to break the link between economic growth and environmental degradation. It also aimed to achieve full and productive employment and decent work for all women and men, including young people and people with disabilities (SDG Report, 2022). Achieving the eighth objective will reduce rural migration to metropolitan regions for suitable employment. Finding decent work is particularly difficult for some workers with impairments, women, young people, and migrants, who also may be more susceptible to mistreatment. In rural areas, modern agricultural activities offer jobs for people of all ages and contribute to the realisation of sustainable objectives.

The study also aligns with the African Union's Agenda 2063, which aims to achieve a high standard of living, quality of life, and well–being for all citizens, with a focus on eradicating poverty, inequality, and hunger (Goal 1) and modernising agriculture to increase productivity (Goal 5). Furthermore, Ghana's Long–Term National

Development Plan (LTNDP, 2018-2057) envisioned an efficient and inclusive agricultural sector capable of feeding the nation and local industries while exporting to international markets, with agro-processing as a primary growth area.

1.2 AGRICULTURAL SECTOR IN GHANA

A fifth of Ghana's Gross Domestic Product (GDP) comes from agriculture, which also employs almost half of the workforce and provides the majority of the country's poorest people with their primary source of income (Ghana Agriculture Sector Policy Note, 2017). Despite the importance of the agricultural sector, this report claims that it is characterised by low yields for both cash and staple crops. As a result, rice, poultry, sugar, and vegetable oils are among the fundamental foods Ghana imports on a net basis. Therefore, the report suggested increasing research to encourage farmers to use new technology. In response to this call, this study aims to investigate farmer adoption behaviour of agricultural technology from a consumer behaviour perspective to develop strategies to promote the adoption of agricultural technology among smallholder commercial farmers to increase food production and improve rural farmers' economic well-being.

The Ghanaian government has created a framework for implementing several policies known as the Food and Agriculture Development Policy to modernise Ghana's agricultural industry (FASDEP). Following the objective set for the sector in the Ghana Poverty Reduction Strategy (GPRS), the first FASDEP was developed in 2002 to build on the fundamentals of the Accelerated Agricultural Growth and Development Strategy (AAGDS). The second issue, published in August 2007, focused on commercialising sector operations to market-driven growth. It targets poor, risk-averse, and risk-prone farmers while attempting to improve the environment for all farmers. When creating FASDEP II, a thorough stakeholder consultation approach was used, and lessons from implementing FASDEP I were incorporated.
The agricultural sector in Ghana has undergone substantial changes. However, the sector is now more vulnerable to problems like food insecurity (Banson,

Nguyen & Bosch, 2015b). Like Ghana, the majority of developing nations lack food security. Food security is present when everyone, at all times, has physical and financial access to sufficient, safe, and nourishing food that meets their dietary needs and preferences for a high standard of living (FAO, 1996). Ruane and Sonnino (2011) state that prolonged famine affects one in six people in most developing countries. The International Fund for Agriculture Development of the United Nations, IFAD (2019) said this is due to a lack of purchasing power, food availability, an uneven distribution of food, and insufficient use of food at the household level. In addition, the land base has been under more pressure due to population growth. The available agricultural land per rural resident has decreased by 18% due to the rural population's steady growth. However, the amount of arable land increased to allow for a 52% rise per rural person due to clearing virgin land and shortening fallow periods (Hazell, Diao, & Magalhaes, 2019).

Despite consistent development, the International Fund for Agricultural Development (IFAD, 2019) notes that Ghana's agriculture is still mostly rain-fed, labour-intensive, and subsistence-oriented. Approximately 80% of farmers are smallholders with fewer than two hectares of land (Banson, Nguyen & Bosch, 2018; Anang, Bäckman & Sipiläinen, 2016). Another obstacle facing Ghana's agricultural sector is the degradation of the land and the depletion of soil nutrients. In sub-Saharan Africa, Ghana has the highest rates of soil nutrient depletion and the lowest rates of yearly inorganic fertiliser application (MoFA, 2018). In 2013, for instance, 12% of homes used organic fertiliser, 30.8% used inorganic fertiliser, and 1.8% used both. However, 65.7% of people utilise chemicals (IFAD, 2019).

Furthermore, there is insufficient research or utilisation of improved planting materials to address emerging challenges, such as shorter and more resilient types of crops and market demand. Additionally, just 0.4% of the agricultural area is irrigated formally, and 3% is irrigated on a modest scale by private individuals (MoFA, 2018). Farmers' yields and incomes are poor and unstable due to their dependence on sporadic rainfall. In the North, where 80% of households depend on agriculture and only one unpredictable rainy season, access to irrigation is minimal. According to the World Food Programme in Ghana, the circumstance significantly impacts poverty rates and leads to seasonal food security (WFP, 2012). The United Nations Food and Agricultural Organization Country Policy Profile of Ghana states that farmers face increased risks due to longer rainy seasons, greater numbers of disasters, including drought and flood, and increased rainfall unpredictability (FAO CPP, 2013).

Additionally, Ghana is characterised by a lack of access to agricultural automation and labour. The Agricultural Mechanization Service Centres (AMSEC) programme was started in 2007 to increase farmers' access to tractors. By 2015, one tractor for every 1,530 farmers had been distributed. However, the poor utilisation of these centres and expensive maintenance resulted in high costs for farmers and weak sustainability of the effort. Furthermore, post-harvest losses restricted Ghana's agricultural economy. Fruits and vegetables experience particularly substantial post-harvest losses. For instance, 45% for mangoes and 37% for tomatoes. 15% for maize and 21% for cassava are the post-harvest losses for cereals. Poor farm-level practices, careless handling during transportation, and insufficient storage, which exposed products to pests and diseases, are to blame for these losses (IFAD, 2019).

Another barrier to Ghana's agriculture sector is the rural infrastructure. Low product volumes, bad road and network conditions, and high transport costs negatively affect the sector. From farms to markets, farmers are required to carry agricultural products on their heads. According to Ofana, Efefiom and Omini (2016), the lack of basic infrastructure for agriculture in the economy is a major barrier to agricultural development and a major deterrent to downstream agribusiness operations. The time available to farmers for productive operations was further diminished by this circumstance and their limited access to energy and clean water. Additionally, smallholder farmers struggle with their lack of access to rural financing and advisory services (IFAD, 2019). According to Ofana et al. (2016), access to more formal credit for smallholder farmers has been challenging regarding availability, timing, volume, and security. In addition, loans have primarily come from informal sources at exorbitant rates. In 2017, there was just one public extension agent for every 1,885 farmers. Agricultural extension agents have a significant impact that cannot be understated. However, farmers lacked the technical assistance typically offered by these qualified agronomic staff (IFAD, 2019). Farmers in underdeveloped economies have traditionally had difficulty obtaining finance in the agricultural industry (Sarker, Wang, Adnan & Sattar, 2020). The absence of a secure system of land tenure is another issue. Farmers and headers in some regions compete and occasionally conflict over land use for livestock or agricultural production (IFAD, 2019). From the above discussion, it is evident that Ghana’s agricultural sector needs much improvement to meet the Sustainable Development Goals by 2030. In response to this need, the Government of Ghana established incentive packages to support farmers in the agricultural sector.

1.3 INCENTIVES TO SUPPORT THE AGRICULTURAL SECTOR IN GHANA

In Ghana, several attempts have been made to provide incentives for farmers. For example, the International Fund for Agricultural Development (IFAD) loans help Ghana's Shared Growth and Development Agenda, which aims to speed up agricultural modernization, strengthen sustainable natural resource management, and boost private-sector competitiveness (IFAD, 2019; Nyasimi, Amwata, Hove, Kinyangi & Wamukoya, 2014). Through initiatives like Feed the Future (FTF) USAID-Ghana, which, among other things, aimed to improve policies that enable private sector development, commercialisation, and use of improved agricultural inputs to increase smallholder incomes and productivity, farmers have been exposed to improved agricultural technologies (FTF, 2011). Additionally, the goal of the Agriculture Technology Transfer Project (ATT Project) was to increase the accessibility and use of agricultural technologies in the rice, soybean, and maize value chains by strengthening outreach capacities through Information Communication Technologies (ICT) mechanisms, developing local research capacities, and promoting labour-saving technologies (Kouadio & Lulu, 2018). The ADVANCE I and II initiatives were also implemented to enhance smallholder agricultural systems to adapt to and mitigate climate change while ensuring food security. Its climate-smart agriculture (CSA) programme seeks to raise farmer knowledge and CSA acceptance while boosting crop output and profitability (Ghana ADVANCE II, 2018).

Importing tractors via bilateral agreements to offer farmers at subsidised prices is another example of government support for agricultural development. Furthermore, subsidies for farming inputs and a seed policy allow for more private participation. Private mechanisation centres, such as Agricultural Mechanization Services Centres (AMSEC), have been subsidised by the government since 2007. However, equipment capacity utilisation has been low, administrative costs have been high, and a spare parts network has been lacking (Houssou, Johnson, Kolavalli, & Asante–Addo, 2016a; Houssou, Aboagye & Kolavalli, 2016b).

The Ghanaian Ministry of Food and Agriculture has recently launched initiatives to support and advance the agriculture industry. As a result, the sector had tremendous growth during the past two years, thanks to the intensification of agricultural activities. As a result, the real agricultural GDP increased from 2.9% in 2016 to 6.1% in 2017, 4.8% in 2018 and 4.6% in 2019 (MoFA, 2021). A total of 1,736,510 farmers had benefited from improved seeds and subsidised fertilisers through the Planting for Food and Job initiative as of the end of 2020. Farmers received an increase in improved seeds of 60%, from 18,333MT in 2019 to 29,500MT in 2020. Additionally, the amount of government-subsidised fertilisers provided to farmers grew by 28%, from 331,354MT in 2019 to 424,000MT in 2020 (MoFA, 2021). The yields increased significantly as a result of these measures. From a starting point of 1.8MT/Ha, maize yields grew to 3.8MT/Ha in 2019. In addition, yields of rice and soya grew by 29% and 59%, respectively, from 1.7 MT/Ha in 2016 to 4.3 MT/Ha in 2019 and 2.7 MT/Ha to 4.3 MT/Ha in 2019, respectively. Over the previous four years, these results have increased the agricultural sector's self-sufficiency in rice production from a low level of 30% to around 50% (MoFA, 2021). However, due to the substantial reliance on increasing the cropped area rather than switching to more intensive farming practices that can boost land productivity, there are questions regarding the sustainability of these accomplishments (Hazell, Diao & Magalhaes, 2019).

Rainfall is necessary for agriculture. There are few irrigation technologies. The government established the Ghana Irrigation Development Authority (GIDA), formerly the Land Planning and Soil Conservation Unit (LPSCU), in the early 1960s. The Irrigation Reclamation and Drainage Division (IRDD) was created by this department and has been given division status. However, the Irrigation Department, which was autonomous under the Irrigation Development Authority Decree of 1977 (SMCD 85), was further changed from the IRDD into a full Department of the Ministry of Food and Agriculture in 1974. Through formulating, regulating, and implementing appropriate policies to benefit farmers, industry, and institutions in a sustainable environment, GIDA aims to provide effective and efficient agricultural water management services and maintain dependable irrigation systems for a sustained benefit to the national economy. Numerous irrigation plans exist in Ghana's Volta Region, the research area. The ten irrigation projects are listed in Table 1.1, along with their locations, potential area in hectares, and developed area. The Ministry of Food and Agriculture estimates that irrigation covers 15 square kilometres with a potential irrigable area of 250 square kilometres (MoFA, 2021).

Table 1. 1 Existing Public Irrigation Schemes developed by GIDA in the Volta Region

Region	Number of Schemes	Location	Potential Area (ha)	Developed Area (ha)	Status of Scheme

Volta	10	Kpando Torkor	356	50	Existing
		Weta (Afife)	950	880	Existing
		Dordoekope	68	68	Existing
		Aveyime	150	150	Existing
		Afaode	78	78	Existing
		Volo	60	60	Existing
		Agorveme	72	72	Existing
		Koloe-Dayi	30	30	Existing
		Tordzinu	4	4	Existing
		Torgorme	2000	450	Existing

Source: MoFA, 2021

Despite government interventions, Ghana's agricultural sector faces challenges, with adoption rates as low as 58%, well below the Sub-Saharan Africa average (Chapoto & Ragasa, 2013). Given the enormous potential of agricultural technology, farmer adoption in Ghana appears to be too late. Did the incentives consider farmers' psychological, social, and personal orientations? The result is that the agricultural sector, which has undergone major economic and social changes since the start of the democratization process in 1957, is continually confronted with issues such as food insecurity, slow adoption of agricultural technologies, and farmer poverty (Banson, Nguyen, & Bosch, 2015; 2018). The usage of agricultural inputs was erroneous. Cutlasses and hoes were used as farming instruments, resulting in labour-intensive agriculture, and these farming instruments were readily available on the market. Improved rural infrastructure, water, and power were among the government's measures to assist farmers. Attempts to restructure the agricultural sector extend back to the post-independence period when the government invested in private and public products to boost farm output. Nevertheless, Ghana continues to struggle with food insecurity, a lack of government incentives in the agricultural sector, and rising farmer poverty.

1.4 SMALLHOLDER COMMERCIAL FARMING IN GHANA

Smallholder farmers in Ghana are under cultivation of fewer than two hectares of land (Banson et al., 2018; Anang et al., 2016). Historically, there have been a variety of empirical estimates of smallholder commercial farmers' landholding. According to Nyanteng and Seini (2000), three hectares or smaller holdings account for almost 90% of Ghana's food production. According to Owusu-Baah (1995), the average farm size is 3.9 hectares, and more than 50% of smallholders own less than three hectares of land. Smallholder farming in Ghana is associated with scarce access to land, resource-poor farmers, fragmented holdings, risk exposure, lack of wealth availability, and a lack of market orientation (Chamberlin, 2007). According to the description of a smallholder farmer provided above, the size of the landholding is frequently employed as an indicator of smallholder farming. According to Pannell, Llewellyn and Corbeels (2013), resource-poor smallholder farmers are constrained by the lack of crucial resources like labour and finance. Therefore, they are likely to be highly risk-averse, meaning they would be willing to give up some of their expected income to lower the likelihood of earning less than the average income. This shows that smallholder farmers who lack access to resources shy away from riskier agricultural ventures. They cannot forgo money since they must meet the immediate demands of their family.

Additionally, smallholder farmers are distinguished by their dispersed holdings. This indicates that a farmer cultivates a lot of dispersed lands. Fragmented farm structures are expensive in production and transaction costs and limit mechanisation, according to Wang et al. (2020). Smallholder farmers, once more, have restricted access to inputs. Smallholder farmers' access to resources, including pesticides, herbicides, insecticides, rodenticides, tractor services, financing, land, labour, a wider choice of seeds, and fertiliser, is constrained (Ajah & Nmadu, 2012).

In their study on the impact of microcredit on smallholder rice farmers' technical efficiency in Northern Ghana, Anang et al. (2016) claimed that the conditions mentioned above of smallholder farmers, coupled with the low adoption of agricultural technology, led to low yields and income among smallholder farmers.

It is understandable why there is rural poverty and frequent food insecurity. Agricultural intensification tactics and contemporary agricultural technology are required as a countermeasure to the threat to boost farm productivity and lower farmer poverty. According to Asodina, Adams, Nimoh and Asante (2021), who looked into the effectiveness of production among commercial soybean farmers in the Upper West Region of Ghana, the smallholder farmers in Ghana received training in contemporary agronomic methods. They were given access to high-yielding varieties, fertilisers, inoculants, pesticides and insecticides. However, the industry is struggling with food insecurity and the inability even to obtain agricultural products for commercial use, let alone supply the demand for food.

In commercial farming, crops and livestock are grown and sold to generate income. Modern techniques are frequently used in commercial farming operations to produce on a large scale. In order to achieve this, the Ghana Commercial Agriculture Project (GCAP), a private-sector initiative funded by the World Bank and the United States Agency for International Development (USAID), was launched in 2013. Its goal is to increase access to stable markets for agricultural inputs and outputs, water, land, and finance while enhancing agricultural productivity in several project intervention areas in Ghana.

The Tono Irrigation Scheme in the Kassena-Nankana District of the Upper East Region of Ghana and the rehabilitation of the Kpong Irrigation Scheme in the Lower Manya Krobo District of the Eastern Region of Ghana have both seen their completion as a result of the GCAP project, which included the construction of canals, 26.5 kilometres of farm roads, and 1,200 hectares of land with improved irrigation (MoFA, 2021). In addition, Ghana's Ministry of Food and Agriculture administers initiatives funded by international organisations on behalf of the country's smallholder commercial farmers. These interventions aim to enhance smallholder commercial farmers' operations to boost farm output and lessen poverty in rural areas. These interventions yielded positive results, and smallholder commercial farmers in Ghana cultivate a variety of agricultural products, namely, rice, maize, plantain, palm oil, yam, cocoa, cotton, coffee, cashew, cassava, peanut, orange, pineapple, lemon, lime, grape, ginger, mangoes, banana, avocados, guava (Hashmiu, Agbenyega & Dawoe, 2022; Zakaria, Alhassan, Kuwornu, Azumah & Derkyi, 2020; Akrofi-Atittianti, Ifejika Speranza, Bockel & Asare, 2018).

1.5 PROBLEM BACKGROUND

Behaviour is understood as changes concerned with behavioural dynamics (Ajzen, 1991) and is described as the underlying overt behaviour induced by internal motivation patterns (Bergner, 2011). Adoption strategies of agribusiness or individual farmers impact farmers' internal motivation. The production of food for human consumption, economic success, excitement for the farming profession, and lifestyle benefits from agricultural operations may all motivate farmers (Valeeva, Lam & Hogeveen, 2007). As smallholder commercial farmers in Ghana work to increase agricultural yield and production, wealth, and access to government farming incentives, agricultural technology adoption strategy will be critical to their competitive success (Kumar, Engle & Tucker, 2018). The main question is: which consumer behaviour elements are appropriate for agricultural technology adoption strategy?

The element of consumer behaviour presented by marketing experts is evaluated to understand and answer the above question appropriately. This knowledge helps to understand the power of the psychological component of the technology adoption strategy and the appropriate application of this element in developing the technology adoption strategy. For example, stylish advertisements and advertising messages generate customers' interest in goods and services - which is a norm for advertisers (Keller, 2016). Other instances of manipulating customer purchasing decisions through images and emotional video and audio messages are known to attract attention, stimulate needs and desires, and evoke emotions, nostalgia and fear (Kotler, 2017). These instances threaten or encourage psychological, social, and personal interest through imagery and word association.

The benefits of adopting modern agricultural technology to boost food production include decreased hunger, malnutrition, and poverty, increased incomes for impoverished rural farmers and cheaper food prices. However, the rate at which farmers adopt these technologies remains very low with growing hunger, low productivity, limited access to technology, poor quality products, poor and un-remunerative external markets, poor service quality, high production and transaction costs and concern about food insecurity (Banson, Nguyen and Bosch, 2018). Agriculture in Africa, especially Ghana, is constrained by high levels of competition and regulation (Bationo & Waswa, 2011). It is characterised by a lack of government incentives to promote and encourage farming operations. In other countries, this is not the case. For instance, the European Union launched the European Innovation Partnership for Agricultural Production and Sustainability (EIP-AGRI) to encourage innovation in the agriculture sector to prepare it for today's global challenges. It was established to organise project financing, networking, and knowledge-sharing activities under the Common Agricultural Policy (CAP). Farmers, farm consultants, scientists, and other stakeholders work together in the project to create and fund creative solutions to practical challenges and modernise agriculture. Government incentives in some member countries reward growers sufficiently to address farmers' psychological, social, and personal needs.

Due to harsh environmental conditions and low precipitation, the agricultural sector in Saudi Arabia, for example, cannot grow at the desired level without government incentives. The government introduced long-term interest-free loans, easy credit schemes, and duty-free imports of agriculture-related raw materials and technologies to boost the sector's productivity. Despite the harsh climate, Saudi Arabia imported only 11% of agricultural products (Hasanov and Shannak, 2020), while Ghana imported 20% of all merchandise in 2018. Adopting agricultural technology in Ghana necessitates changes in government policy and incentives.

Against this backdrop, a strategy that leverages consumer behaviour elements to promote improved agricultural technology adoption becomes more necessary.

Nevertheless, the necessity of adopting agricultural technology remains contrived by a limited understanding of elements of consumer behaviour. Therefore, this approach will be used to develop a behaviour strategy appropriate for adopting agricultural technology in Ghana using psychological, social and personal aspects.

1.6 PROBLEM STATEMENT

When farmers adopt modern farm technologies, they significantly impact national food security. Improved agricultural technology is incorporated into farming operations to boost output and improve household well-being. Farmers' increased income from agricultural products fuels economic growth and poverty eradication. Additionally, everyone can afford the low prices of basic foods. Further, as technology improves systems and systems enhance productivity, adopting agricultural technology increases efficiency and cost savings (Chando & Yuansheng, 2018; Jost, Kyazze, Naab, Neelormi, Kinyangi, Zougmore & Kristjanson, 2016). Utilising agricultural technology enables farmers to grow a wider array of crops, improving crop variety (Awotide & Awoyemi, 2016). Farmers now have access to new crop varieties that can endure climate change and can get rid of old crops that are not climate resistant.

Despite the great benefits of adopting improved agricultural technology, most farmers have been reluctant to adopt agricultural technology, making farming unprofitable (Asfaw, Shiferaw, Simtowe & Lipper, 2012). This is because although the use of agricultural technology and innovations has a positive impact on the economic and social viability of farming, farmers have continued to utilize antiquated or conventional agricultural practices that hardly accomplish yield maximization and low cost of production (Adnan et al., 2018). According to Eifert, Gelb and Ramachandran (2008), the situation has led to low productivity, poor quality products, unsatisfactory services, and excessive production and transaction costs. In addition, dominant numbers of traditional smallholder commercial farms cover less than two hectares of farmland across rural Ghana. As a result, these smallholder farms record poor yields, which result in poverty and food insecurity in rural areas (Banson et al., 2018). Therefore, a strategy to adopt agricultural technology is needed to support these smallholder commercial farmers in ensuring profitability and sustainable food security, promoting farm yield, and reducing poverty.

The proposed adoption strategy would utilise past and present experience to develop an adoption strategy that is effective, useful and responsive to the food security and sustainability needs of farmers. It is hoped that the proposed adoption strategy can induce government support and training programmes for farmers to achieve the objective of poverty alleviation and food security in Ghana. In addition, the relationship between the psychological, social, and personal characteristics of farmers' behaviour can be leveraged to promote adoption of agricultural technology among farmers.

1.7 AIM OF THE STUDY

This study aims to use a marketing approach to help farmers understand the dynamics involved in adopting agricultural technology. Understanding the complexities of adoption behaviour from a practical point of view can assist stakeholders in the agricultural sector in designing effective strategies that improve agricultural technology adoption among farmers. Furthermore, integrating adoption behaviour, psychology and marketing principles into this study adds to the marketing philosophy and helps develop marketing practices in Ghana.

1.8 RESEARCH QUESTIONS

The main research question was: What is the relationship between the consumer behaviour elements and the Agricultural Technology adoption willingness of Ghana's smallholder commercial farmers?

The following subsidiary research questions stemmed from the main research question:

1. What is the relationship between the perceived usefulness of technology and farmers' willingness to adopt Agricultural Technology?
2. What is the relationship between the perceived ease of use of technology and farmers' willingness to adopt Agricultural Technology?
3. What is the relationship between peer influence and farmers' willingness to adopt Agricultural Technology?
4. What is the relationship between superior influence and farmers' willingness to adopt Agricultural Technology?
5. What is the relationship between attitude and farmers' willingness to adopt Agricultural Technology?
6. What is the relationship between self-efficacy and farmers' willingness to adopt Agricultural Technology?
7. What is the relationship between the complexity of technology and farmers' willingness to adopt Agricultural Technology?

1.9 HYPOTHESES

1.9.1. Main hypotheses

There are significant relationships between the consumer behavioural attributes of farmers and their willingness to adopt Agricultural Technology.

1.9.2 Subsidiary hypotheses

H1: There is no significant relationship between the perceived usefulness of technology and farmers' willingness to adopt Agricultural Technology.

H2: There is no significant relationship between the perceived ease of use of technology and farmers' willingness to adopt Agricultural Technology.

H3: There is no significant relationship between peer influence and farmers' willingness to adopt Agricultural Technology.

H4: There is no significant relationship between superior influence and farmers' willingness to adopt Agricultural Technology.

H5: There is no significant relationship between the attitude and farmers' willingness to adopt Agricultural Technology.

H6: There is no significant relationship between self-efficacy and farmers' willingness to adopt Agricultural Technology.

H7: There is no significant relationship between the complexity of technology and farmers' willingness to adopt Agricultural Technology.

1.10 OBJECTIVES

This section outlines the objectives of the study. The main objective is first stated and followed by the subsidiary objectives.

1.10.1 Main objectives

The main objective of this study is to explore the relationship between consumer behaviour elements and the willingness of Ghana's smallholder commercial farmers to adopt agricultural technology.

1.10.2 Subsidiary objectives

The subsidiary objectives for this study are to:

1. Investigate the relationship between the perceived usefulness of technology and farmers' willingness to adopt Agricultural Technology.
2. Investigate the relationship between perceived ease of use of technology and farmers' willingness to adopt Agricultural Technology.
3. Investigate the relationship between peer influence and farmers' willingness to adopt Agricultural Technology.

4. Investigate the relationship between superior influence and farmers' willingness to adopt Agricultural Technology.
5. Investigate the relationship between attitude and farmers' willingness to adopt Agricultural Technology.
6. Investigate the relationship between self-efficacy and farmers' willingness to adopt Agricultural Technology.
7. Investigate the relationship between the complexity of technology and farmers' willingness to adopt Agricultural Technology.
8. Develop a consumer behaviour Technology Adoption strategy for farmers in Ghana based on the relationships.

1.11 SIGNIFICANCE OF THE STUDY

This section explains the study's significance by explicitly dividing it into three subheadings: significance to theory, practice, and policy.

1.11.1 Significance to theory

Smallholder commercial farmers' adoption of agricultural technology was theoretically studied from the standpoint of consumer behaviour in marketing. Using adoption theories like the Technology Acceptance Model TAM, Diffusion of Innovations Theory DoIT, and the Decomposed Theory of Planned Behaviour DTPB, it was possible to establish the relationship between smallholder commercial farmers' consumer behavioural traits, such as psychological, social, and personal traits, and their willingness to adopt agricultural technology. This study expands the marketing theory of consumer behaviour in agriculture technology adoption, and it is scientifically very unique.

1.11.2 Significance to practice

The study significantly contributes to the marketing body of knowledge and farmer education in adopting agricultural technologies to promote productivity. A significant factor responsible for high productivity in the agricultural industry is the incorporation of new technologies to meet the increasing demand for food, create jobs, alleviate poverty, generate income, and enhance economic development (SDGs 1, 2, and 8).

The government of Ghana provides incentives for farmers to boost agricultural yield. As a result, farmers enjoy tax holidays of five years for cash crops and livestock production for both farmers and companies engaged in agricultural processing, reduced tax rates after the entire years of tax concession, ten-year income tax exemptions, and zero % import duties on equipment are among the fiscal incentives available. However, complicated bureaucratic processes that require some farmers to pay bribes to gain access have hampered the efficacy of these fiscal incentives. Moreover, many farmers cannot obtain sufficient credit from banks due to a lack of collateral security, high interest rates, and unfavourable loan repayment conditions (Teye, 2019). As a result, the agricultural sector in Ghana is struggling to meet the demand for food. For example, locally produced rice meets only 50% of rice demand in Ghana. The uniqueness of the study’s outcome stems from the consumer behaviour strategy to assist smallholder rice farmers in increasing the adoption of agricultural innovations in a quest to increase agricultural yield, eradicate poverty and improve the social well-being of farmers.

1.11.3 Significance to policy

This research significantly impacts global, Sub-Saharan, and Ghanaian policy directions. The Ministry of Food and Agriculture (MoFA) and other decision-makers, farmers, and international organisations would profit from the study's findings. The study could aid in increasing agricultural technology adoption to raise farm output, promoting economic growth and ensuring food security. This uniqueness emanates from the fact that it looks at the adoption of agricultural technology from the perspective of consumer behaviour. Consumer behaviour aims to understand what customers (farmers) want and need so that products (agricultural technologies) that can meet those needs can be offered. In order to increase the adoption of agricultural technology among smallholder commercial farmers in Ghana, this study established a relationship between the psychological, social, and personal traits of farmers and the behavioural dimensions of technology adoption to develop strategies to improve the adoption of agricultural technology. More innovative agricultural technology is essential to increasing agricultural productivity and reducing rural poverty (Michler, Tjernstrom, Verkaart & Mausch, 2019; Thompson et al., 2019). The findings of this study would help the World Bank, the Food and Agricultural Organization of the United Nations (FAO), non-governmental organizations (NGOs), and other development organisations will all benefit from the study because the strategies created will use a marketing perspective to increase the adoption of agricultural technology.

1.12 SCOPE OF THE STUDY

Although there are modern research works on agricultural technology adoption behaviour (Salimi, Pourdarbani and Asgarnezhad Nouri, 2020), to the best of knowledge of the research, this is the first research developing consumer behaviour strategy to improve agricultural technology adoption behaviour among farmers in Ghana. This is a novel solution to the problem faced by the agricultural sector in Ghana and the whole of Africa. This study focuses on the broad conception of consumer behaviour and technology adoption.

The study examines how consumer behaviour influences farmers who use agricultural technologies. The complex phenomenon of consumer behaviour has been researched for many years if not millennia (Trudel, 2019; Thgersen, 2021). Various consumer behavioural characteristics in the agriculture sector influence farmers' adoption of agricultural technology. Cultural, social, personal, and psychological aspects are among them (Schiffman and Kanuk, 2007; Hervé and Mullet, 2009; Diallo, Chandron, Cliquet & Philippe, 2013). The three factors—psychological, social, and personal—that affect farmers' decisions to use agricultural technology are considered in this thesis. Farmer motivation drives the psychological component of farmer behaviour toward adopting agricultural technologies. According to their needs, farmers are motivated to embrace agricultural technology (Thilmany, Bond & Bond, 2008). Depending on the unique agricultural activities and requirements, farmers may have different needs.

Additionally, a farmer's adoption behaviour is psychologically influenced by information about a specific agricultural technology (Coffie, 2015). In general, advertisements or word-of-mouth recommendations help consumers develop an impression of a product. This shapes how that product is perceived and affects the decision to buy. Purchase decisions are psychologically influenced by the attitudes and beliefs that consumers consciously or unconsciously hold. Farmers are more likely to adopt a technology if they believe in it and see it favourably. However, when people have unfavourable attitudes and beliefs about agronomic innovation, such technology is rejected (Rödiger & Hamm, 2015). These aspects of the psychological factors influencing consumer behaviour are the extent of this study.

The social elements impact consumer behaviour when deciding what to buy. Agricultural technology adoption decisions made by farmers can be based on both socially proximal and distant referents. Farmers' families and close friends significantly influence their decision to adopt. The decision of a farmer to adopt agricultural technology is greatly influenced by recommendations from friends, relatives, or the adoption outcomes of these socially proximal referents, just as reference groups are influential on consumer purchase decisions (Cocanougher and Bruce, 1971; Kante, Chepken & Oboko, 2018; Sutherland & Marchand, 2021). The effect of peers, families, friends, and other farmers, as well as the superior influence of agricultural extension officers, irrigation scheme managers, and agricultural project administrators, are the only social elements included in this study.

Consumers have personal elements that affect their choices in addition to psychological and social factors. Personal behavioural factors influencing agricultural technology adoption or rejection also impact farmers as customers. These elements are unique to each farmer since they are personal, as the term suggests. For example, their age influences the farmer's choice to adopt or reject agricultural technology. Another evidence of a personal factor that affects a farmer's adoption of agricultural technology is his or her income. While a farmer with a lesser income cannot afford such agronomic advancements, a farmer with a higher discretionary income is more likely to be able to buy more expensive agricultural technologies (Rana & Paul, 2017). The farmers' skills are among the personal variables. This thesis investigates farmers' self-efficacy, attitude, and technical capability concerning the complexity of the technology. It has been demonstrated that farmer attitudes influence whether agricultural technology is adopted (Verma & Sinha, 2018). A farmer's behavioural intentions to use technology are influenced by their sense of self-efficacy. It is the farmer's estimate of their abilities to employ agricultural technology to accomplish farming goals (Sharifzadeh, Damalas, Abdollahzadeh & Ahmadi-Gorgi, 2017).

The thesis's main topic also includes the adoption of new technologies. The adoption of technology in this study refers to how farmers incorporate new agricultural technologies into their current practices (Loevinsohn et al., 2013). With the rising release of new technology come prospective benefits and drawbacks. Farmers carefully assess various critical factors before deciding to implement new agricultural technology. According to Tey and Brindal (2012), important factors that affect the adoption of agricultural technology include socioeconomic factors (such as gender, age, household size, ethnicity, marital status, educational attainment, and employment status of farmers) and agro-ecological factors (such as size, land tenure, location, capital, sales/profit, and the main crop of a farm). The goal of this study is not to prove a connection between these variables and farmers' desire to use agricultural technology. Instead, this thesis aims to apply a consumer behavioural perspective to analyse farmer adoption behaviour to offer strategies for increasing smallholder commercial farmers' adoption of agricultural technology to boost food security and lower rural farmer poverty.

1.13 THE RESEARCH SETTING

The research setting is the physical, social, or experimental context in which research is done. It is also the location where information is gathered. The research context is critical since the results and their interpretation may be significantly influenced by it. An overview of the study area is provided in this section to help understand why the Volta Region of Ghana was chosen to investigate the smallholder commercial rice farmers' adoption of agricultural technology.

The Volta Region of Ghana is the subject of this research. Ghana is a tropical country in West Africa, with Accra as its capital. It is bordered on the north by Burkina Faso, on the west by Cote d'Ivoire, on the east by Togo, and on the south by the Gulf of Guinea. In 2018, Ghana's population was estimated to be around 29.6 million (World Bank-Ghana, 2022). Fifty-one percent of the population is female, while forty-nine percent is male. The average lifespan is 64.42 years. Ghana's gross domestic product (GDP) was USD 68.53 billion in 2020. (World Bank-Ghana, 2022). Rain Forest zone, Deciduous Forest zone, Savannah Transitional zone, Coastal Savannah, Guinea Savannah, and Sudan Savannah are the six agro-ecological zones in Ghana. These agroecological zones and the wide range of soil types allow for the growth of a wide range of crops (MoFA, 2021). Despite the Coronavirus Disease 2019 (COVID-19) pandemic halting economic growth, Ghana's services sector accounts for 45.01 percent of GDP, followed by the industrial sector at 29.74 percent and the agricultural sector with 19.25 percent in 2020, with a GDP increase of 4.1 percent in 2021 (World Bank-Ghana, 2022). Gold and cocoa beans, as well as other cocoa-related items, are the principal export earners. In addition, Ghana is a major exporter of horticulture crops such as pineapples, mangoes, and citrus fruits. Ghana began commercial crude oil production in 2010 (GoG, 2013). Agriculture is an important aspect of the economy, led by smallholder farmers specialising in food crops. Rice is produced commercially by a few farmers. The Ghana Irrigation Development Authority organises commercial rice producers into schemes (GIDA). GIDA aims to develop and implement irrigation and drainage plans for all year-round agriculture production in Ghana (MoFA, 2021) in all of Ghana's sixteen administrative regions, including Ahafo, Ashanti, Bono, Bono East, Central, Eastern, Greater Accra, Northeast, Northern, Oti, Savannah, Upper East, Upper West, Volta, Western, and Western North.

Volta Region, one of Ghana's sixteen administrative regions, is located west of the Republic of Togo and east of Lake Volta, with Ho as its regional capital. In addition, the greater Accra Region, Eastern Region, and Oti Region all share common borders with the Volta Region. The Region is divided into 18 administrative districts/municipal, namely, Hohoe Municipal, Kpando Municipal, North Dayi, Afadzato South, South Dayi, Ho Municipal, Ho West, Adaklu, Agotime Ziope, North Tongu, South Tongu, Central Tongu, Akatsi North, Akatsi South, Ketu North Municipal, Ketu South Municipal, Keta Municipal, Anloga Municipal. The Ewe people are the Volta Region's indigenous and largest ethnic group. A variety of educational institutions can be found in the Volta Region. There are currently five universities and colleges of the university, eight nursing training and education colleges, and fifty senior high and technical schools.

The Volta Region's top soils include savannah ochrosols, sandy coastal soils, tropical grey earth and regolistic groundwater laterites, topohydric and luthochronic earth, and topohydric and luthochronic earth, all of which allow the region to cultivate diverse food crops. Agriculture is critical to the region's socioeconomic growth. Cereals, legumes, vegetables, oil trees, root and tubers, pulses, and plantation crops are among the industrial and food crops grown in the region (MoFA, 2022). Agriculture is the primary source of income in rural communities. Agriculture and allied activities support more than 80% of the population.

Ghana's four primary rice-producing regions are Volta, Northern, Upper East, and Upper West. The Volta Region, on the other hand, is Ghana's major rice producer. The Region contributes over half of the produce to the national stock, around 400,000 tonnes per year (MoFA, 2022). The region's terrain is favourable, with an undulating environment that produces streams that run through the region's inland valleys, eventually providing water for rice farming. Furthermore, the area's nature provides excellent conditions for rice production in the coastal areas, which have water, a natural resource that boosts agricultural activity. The region produces two crops yearly because of favourable climatic conditions. As a result, May/June and September are the two rice harvest seasons in the Region.

Rice production in the Volta Region is divided into formal and informal categories. Smallholder rice farmers who are not members of any rice farming scheme make up the informal sector. These are subsistence farmers who rely nearly entirely on family labour and rainfall. Because of the adoption of indigenous farming practices, this group of rice producers is not the study's target demographic. The indigenous practices are not scientific technologies; they are produced by farmers based on their ideas and experiences and vary over time (Faye, Hopple and Bridgham, 2020). On the other hand, the formal sector rice farmers are smallholder commercial rice farmers whom the Ministry of Food and Agriculture organises into schemes.

The two primary rice cultivation schemes in the Volta Region are the Weta Irrigation Scheme in the Ketu North District and the Aveyime Irrigation Scheme in the North Tongu District. Small-scale farmers can benefit from GIDA's community-based irrigation infrastructure. The Weta Irrigation Scheme is part of the formal rice farming sector of the Ministry of Food and Agriculture. There are 11 sections to the Scheme. Except for Sections 1 to 4, which include five sub-blocks, A to E, each Section is divided into four blocks, A to D. Weta Irrigation Scheme has 2,164.82 acres of farmed land, and 1,095 rice farmers, 76.6 percent of them are male and 23.4 percent female (Appendix A: Weta Irrigation Scheme - Summary List of Farmers). Two hundred eighty-five rice farmers from the Weta Irrigation Scheme were sampled for this study. The Aveyime irrigation scheme is relatively modest compared to the Weta Irrigation Scheme. It includes 94 farmers as members, with 54 hectares of agricultural land. As of the time of data collection, a third plan had been launched. The Kpoglo irrigation scheme is the name of this project. Due to their proximity, the farmers of the Kpoglo irrigation scheme are nearly identical to those of the Weta Irrigation Scheme. As a result, the Weta Irrigation Scheme was chosen for this study since it contained the most farmers and cultivated land and far higher yearly production than the other two combined.

1.14 ETHICAL CONSIDERATIONS

Ethics plays a vital role in research (Busher & James, 2002; Allmark, 2002). Ethical principles help to guide and safeguard the interest of researchers and the outcome of their study (Armond, Gordijn, Lewis, Hosseini, Bodnar, Holm, Kakuk, 2021; Nichol et al., 2021). There are various ethical protocols and processes that researchers must adhere to in order to ensure that the rights of respondents are respected during the research process (Alderson & Morrow, 2020). These principles include seeking consent, disclosing purpose, and maintaining confidentiality (Knottnerus & Tugwell, 2018). In this study, the first ethical principle that was adhered to was disclosure of purpose. This entailed informing respondents about the purpose of the research and ensuring that they understood what the research was about and the role they were required to play.

In this study, the researcher informed respondents, comprised of rice farmers from Weta Irrigation Scheme, about the research's purpose. This helped in securing their consent and permission to participate in the survey. According to researchers (See Cascio & Racine, 2018), seeking consent from respondents is an important ethical principle that must be respected and adhered to. This study adhered to this principle, and all respondents granted their consent before data was collected via the administration of the questionnaires. Finally, respondents were assured that their details and identities would be concealed and kept private and confidential. Respondents were assured their details would not be sold to external agencies without permission. This is in line with the ethical principle of confidentiality, which has been deemed essential to the integrity of research findings (Surmiak, 2018; Surmiak, 2020).

Other ethical considerations were also made during this study. During data collection, the smallholder farmers were assured confidentiality and anonymity

(Saunders et al., 2016). Participants were also asked not to indicate any particulars that can be traced to them. This would amount to a breach of confidentiality and anonymity. In addition, avoiding specifics when collecting demographic information was ensured. For example, age was expressed as a range, salary as a range, educational qualification as levels, and so on. Each questionnaire contained a statement of the confidentiality of information provided and the purpose of the study, which is purely academic. These were the underlying ethical principles governing the conduct of this study, and due diligence was done to ensure that respondents were treated with the utmost respect to ensure that the integrity of the research process was not compromised.

1.15 ORGANISATION OF THE THESIS

This study is organised into seven chapters. Chapter 1 discusses the introduction to the study, which generally provides an overview, fundamental understanding, and justification of the need to conduct the research. In addition, the chapter includes the problem background, statement of the problem, research questions, hypotheses, objectives, aims, and the study's outline. The second chapter delves into discussions on Ghanaian farmers' adoption of technology. It pointed out the type of agricultural technologies in Ghana and how they are being used. Chapter 3 elaborated on the theories underpinning the study, while the fourth chapter detailed a conceptual framework developed for the study. Chapter 5 entails the research methodology, spelling out the philosophical understanding and position of the researcher and the methods applicable toward selecting participants and collecting data and analysis. Chapter 6 presents and thoroughly discusses the results obtained from data analysis. The final chapter (seven) includes conclusions based on the findings and recommendations for practice and future research. The chapter also captured the limitations of the study.

1.16 CHAPTER SUMMARY

This section of the study highlighted Ghana's agricultural industry, which employs 50% of the workers but is nevertheless plagued by food insecurity and rural poverty among farmers. Several attempts were made to provide different incentives through the Ministry of Food and Agriculture to support Ghana's agricultural sector. The International Fund for Agricultural Development (IFAD) has been to provide credit. The Feed the Future (FTF) USAID-Ghana provided support to improve policies that enable the commercialisation and adoption of improved agricultural inputs, the Agricultural Technology Transfer Project (ATT Project) to improve accessibility and adoption of agricultural technologies, and the ADVANCE I and II projects to enhance agricultural systems to reduce the effect of climate change on agricultural operations and maintain food security. The smallholder farmers in Ghana have land holdings of less than 2 hectares, resulting in low yields and income among farmers. The adoption of agricultural technology significantly impacts food security. The problem is that Ghana’s smallholder farmers are reluctant to adopt improved agricultural technology. The study's hypotheses aimed to determine the significance of the link between farmers' consumer behaviour traits and their readiness to adopt agricultural technologies. The study aims to use a marketing perspective to comprehend the behavioural factors that influence farmer adoption of agricultural technology. The significance of the study was explained, and the scope was clearly defined. The chapter concluded by outlining the study's structure and ethical considerations. The next chapter of the study contains a review of the literature on the adoption of agricultural technology to help understand the concepts that form the basis of the study.

CHAPTER TWO

AGRICULTURAL TECHNOLOGY ADOPTION BY SMALLHOLDER COMMERCIAL FARMERS

2.1 INTRODUCTION

This chapter builds upon the introduction in the previous chapter and focuses on a review of the literature on the adoption of agricultural technology by smallholder commercial farmers in Ghana. It reviews the literature to clarify the key concepts underpinning this thesis. Primarily, the concept of agricultural technology is expounded upon, with a discourse on the types of agricultural technology, benefits and cost of agricultural technology, the adoption of technology by smallholder farmers in Ghana and finally, determinants of agricultural technology adoption.

2.2 AGRICULTURAL TECHNOLOGY

Central to this thesis is the concept of agricultural technology. Worldwide, it has been recognised that agriculture plays a crucial role in the development and progress of nations (Magruder, 2018; Manda et al., 2020; Zhang, Sun, Ma & Valentino, 2020). Moreover, many reports have confirmed the relevance of the agricultural sector to the economy of nations and the global economy as a whole (Michler et al., 2019; Mao, Zhou, Ying & Pan, 2021; Pawlak & Kołodziejczak, 2020). Significantly, agriculture plays an essential role in contributing to the reduction of unemployment by providing employment opportunities to many individuals and families, especially in rural areas in developing countries such as Ghana (Asuming-Brempong, 2004; Diao et al., 2010; Hesselberg, 2013; Ableeva, Salimova, Gusmanov, Lubova, Efimov & Farrahetdinova, 2019; Loizou, Karelakis, Galanopoulos, Mattas, 2019).

The agricultural sector's vital role globally and locally has resulted in an increasing policy and managerial focus on leveraging technology and innovation to improve agriculture output (Omotilewa, Ricker-Gilbert & Ainembabazi, 2019). As a result, various technological advancements have occurred in agriculture over the past decades. They have led to many developments which have contributed to the growth of agriculture and many improvements in the process of planting and harvesting (Shita, Kumar & Singh, 2018; Ugochukwu & Phillips, 2018; Wossen, Alene, Abdoulaye, Feleke, Rabbi, Manyong, 2019). Agricultural technology is, therefore, an essential concept that this thesis seeks to shed more light on.

Agricultural technology has received significant attention in the literature as scholars have become interested in determining how technology can improve agricultural performance and output (Damania, Berg, Russ, Federico Barra, Nash & Ali, 2017; Eberhardt & Vollrath, 2018). Agricultural technology can be described as innovations that birth new crop varieties, new processes for managing agricultural processes, new systems for irrigation and soil management, and new techniques for increasing yield (Alvarez Carrillo, Roselli, Frej, & de Almeida, 2018; Gao, Zhao, Yu, & Yang, 2020; Rola-Rubzen et al., 2020). Many scholars have argued that the adoption of agricultural technology is a panacea for the many challenges that smallholder farmers face; not only does it result in new crop varieties which can improve crop yield, but it can also result in better farm management systems and practices which ultimately result in greater efficiency and effectiveness (Glover, Sumberg, Andersson, 2016; King, 2017; Tian, Wang, Liu, Qiao & Li, 2020). Kumar (2018), for instance, explained that through new agricultural technology, farmers could reduce the cost of production and make marginal and sometimes significant gains in the income generated from the sale of farm produce.

Scholars have made increasing attempts to delineate the concept of agricultural technology (Emerick, De Janvry & Sadoulet, 2016; Magruder, 2018; Kapur, 2018). The consensus in the literature is that agricultural technology is essential for sustainable food production in the 21st century (Senyolo, Long, Blok & Omta, 2018). Torres (2022), for example, explored the adoption of technology amongst beginning farmers in the speciality crop industry. In that study, it was found that adopting agricultural technology helps farmers grow disease-resistant crops, create effective irrigation systems, and improve operational efficiency. Other studies have explored agricultural technology. The consensus is that it refers to applying science and innovation to develop new crops, new irrigation systems and farming methods, which can result in sustainable outcomes (Zeng, Alwang, Norton, Jaleta, Shiferaw & Yirga, 2018; Manda et al., 2020).

Agricultural technology comprises various innovations designed to improve agricultural sector output (Kumar et al., 2018; Kassie, Fisher, Muricho & Diiro, 2020; Michler et al., 2019). These innovations comprise infrastructural innovations, innovations in equipment and machinery, innovations in crop variety, innovations in techniques for irrigation, planting and harvesting (Shita et al., 2018; Adnan et al., 2019; Chavas & Nauges, 2020), as well as general innovations in farm management (Yigezu, Mugera, El-Shater, Aw-Hassan, Piggin, Haddad, 2018; Vecchio, Agnusdei, Miglietta, Capitanio, 2020). This study discusses the adoption of agricultural technology amongst smallholder farmers in Ghana. The following section explores the types of agricultural technology and gives insight into the various forms of technology available for farmers and stakeholders in the agricultural sector.

2.2.1 Types of agricultural technology

A review of the extant literature reveals some classifications of agricultural technology. Some scholars (See Zheng et al., 2022) have classified agricultural technology into three categories: (1) New crop varieties, (2) Water-saving irrigation technology, and (3) Straw-returning technology. According to Zheng et al. (2022, p. 284), “new crop varieties refer to those with stronger disease resistance or more obvious yield-increasing effects than general crop varieties, but the price is relatively high.” Through innovation and continuous scientific research in the agricultural sector, scientists have developed new crop varieties with certain characteristics which can endure certain climatic conditions that previous crop varieties could not (Fernie & Yan, 2019; Qaim, 2020). New crop varieties are, therefore, a type of agricultural technology that entails the development of new breeds and types of crops through scientific crop engineering (Xu, Li, Qi, Tang & Mukwewza, 2016; Halewood, Chiurugwi, Sackville Hamilton, Kurtz, Marden, Welch & Powell, 2018).

According to Zheng et al. (2022), the second classification of agricultural technology is water-saving irrigation technology. This refers to “…production technologies that can effectively save water, such as sprinkler irrigation, micro-sprinkler irrigation, subsurface irrigation and drip irrigation” (Zheng et al., 2022:284). This technology focuses on finding efficient ways to use and conserve water for irrigation. Scholars have found that water-saving irrigation technology is responsible for increased yield and management of the effects of climate change on agriculture (Yan et al., 2020; Zhou et al., 2020). Therefore, this is an essential agricultural technology that helps farmers ensure a reliable flow of irrigation to their farms, which prevents drought and other ill effects that could affect the quality and quantity of harvest.

The third classification of agricultural technology is straw-returning technology (Zheng et al., 2022). According to the authors, “straw-returning technology refers to measures to increase fertility and increase production, which improve traditional incineration methods and avoid air pollution caused by incineration, including straw crushing and pressing, returning to the field with straw mulching, returning to the field by piles, returning to the field by burning, and returning to the field” (Zheng et al., 2022, p.285). In addition, this form of agricultural technology involves using natural sources of minerals to nourish the soil and ensure its vitality for the current and next season. These three types of agricultural technology are essential and play different roles in ensuring that farmers' output is improved continuously.

Other scholars have also classified agricultural technology into two categories: (1) traditional technologies with low risk and (2) innovative technologies with high risk (Tang, Yang, Ge & Chen, 2019). This classification of agricultural technology focuses on the level of risk and the generic nature of the technology being applied; is the technology the traditional type that produces primary outcomes, or is it innovative technology that creates phenomenal outcomes through technological disruption? These questions have been clarified to some extent in the literature. For example, Tang et al. (2019) observed that the type of technology farmers use depends on factors such as funding, credit and insurance. That being said, it is crucial to establish the distinction between these two types of agricultural technology.

Traditional agricultural technology refers to inventions that have existed for decades and have been designed to help farmers execute basic tasks (Allmaras, Wilkins, Burnside & Mulla, 2018; Wazed, Hughes, O’Connor, Calautit, 2018). These types of technology are fundamental because they involve little technical skills and can be used easily (Evenson & Evenson, 2019; Zhang et al., 2020). They are not complex and do not require extensive training to understand. Another defining characteristic of traditional agricultural technology is that it is less risky than dynamic and innovative agricultural technology (Fielke et al., 2019; Rotz, Duncan, Small, Botscher, Dara, Mosby & Fraser, 2019). Simple traditional agricultural technology can be acquired with meagre funds and does not require access to significant capital to acquire (Timsina, Ghimire, Gauchan, Subedi & Adhikari, 2018; Berhanu, Angassa & Aune 2021). On the other hand, innovative agricultural technology refers to modern agricultural inventions resulting from years of Research and Development (R & D) that have been finetuned several times to deliver an innovative outcome (Bechar & Vigneault, 2016; Pigford, Hickey & Klerkx, 2018).

In examining these two classifications of technology, scholars have opined that traditional agricultural technology has limitations in that it often relies on workforce and significant human exertions (Schut, van Asten, Okafor, Hicintuka, Mapatano, Nabahungu & Vanlauwe, 2016; Douthwaite & Hoffecker, 2017). On the other hand, innovative agricultural technology requires little exertion but increased concentration and monitoring (Wigboldus, Klerkx, Leeuwis, Schut, Mullerman & Jochemsen, 2016; Eastwood et al., 2017; Maria et al., 2021). Aside from the cost factor, the distinction between these two types of agricultural technology lies in the fact that one will result in reasonably basic output, while the other can achieve phenomenal output (Dolinska & d'Aquino, 2016; Röling, 2019). That notwithstanding, it is clear that the choice of which type of technology to use depends on many factors, not least the cost and risk of using the technology (Rotz et al., 2019; Fielke et al., 2020).

In other research, agricultural technology has been conceptualised to include the various modernised techniques and farming practices that positively impact agricultural output growth (Jain et al., 2009; Mao et al., 2021; Ramirez, 2013). Scholars like Loevinsohn et al. (2013) have opined that, mainly when it comes to the issue of agricultural technology, the development and promotion of new crops are at the top of the agenda. Scientists constantly strive to develop new varieties to help farmers improve their crop yield and general output (Qaim, 2020). This often leads to higher returns on investment due to the resilience and productivity of new crop varieties. As such, agricultural technology includes not only new equipment and processes but also new systems, crop varieties and new harvesting methods, ensuring farmers obtain better output. The definition and types of agricultural technology are summarised by Loevinsohn et al. (2013), who claim that new forms and supervision systems, fertility of the soil handling, herbicide and insect control, and irrigation and water handling are all forms of agricultural technology that improve farmers' productivity.

Still, studies identify various agricultural technologies adopted from the production, processing and post-harvest operations. Yield-enhancing agricultural technologies such as fertiliser application, improved seeds, irrigation, increased soil tillage, integrated pest management and bulky technologies such as mechanised ploughing, harvesting and planting (Habtewold, 2021, Hu, Li Zhang & Wang, 2019). Post-harvest technologies include branding, transportation, marketing of farm produce, standardization and financing (Zhang, Sun, Ma & Valentinov, 2020). Also, Hu, Li Zhang and Wang (2019) identified land-saving technology, including greenhouses or zero grazing. In this study, adopting agricultural technology refers to adopting yield-enhancing agricultural technologies, including mechanisation. The following section examines the benefits of agricultural technology.

2.2.2 Benefits of agricultural technology

In this section, the researcher explores and discusses the benefits of agricultural technology. These benefits include improved crop varieties, improved efficiency and cost savings, lower staple food prices, increased earnings and eradication of poverty, improved yield and harvest, environmental conservation and sustainability and ultimately, food security.

2.2.2.1 Improved crop varieties and harvest

One of the important benefits of adopting agricultural technology is improved crop varieties (Awotide & Awoyemi, 2016). Through the adoption of agricultural technology, farmers can access new varieties of crops, which are often engineered to perform better than previous varieties (King, 2017; Kuehne, Llewellyn, Pannell, Wilimson, Dolling, Ouzman & Ewing, 2017). This feature and benefit of agricultural technology are documented in the literature (Fernie & Yan, 2019). Agricultural technology has helped farmers overcome the challenges that climate change posed concerning old varieties of crops which were not resilient enough to withstand the present climate effects (Agarwal, 2018; Edwards, 2020). However, scientists and researchers have observed that the new varieties of crops resulting from agricultural technology are more resilient and able to withstand the pressures of the current climate whilst also outperforming old varieties in yield and harvest (Pan et al., 2018).

2.2.2.2 Improved efficiency and cost savings

It has also been established that agricultural technology results in greater efficiency and cost savings (Chandio & Yuansheng, 2018; Kansanga, Amderson, Kpienbaareh, Mason-Renton, Ayuoye, Sano & Luginaahet, 2019). Scholars such as Kariyasa and Dewi (2013) posit that agricultural technology improves productivity and enhances socio-economic development. This view is shared by other scholars who also believe that agricultural technology can result in greater efficiency and cost savings (Fuglie, 2016; Baltes, Gil-Humanes, Voyta, 2017). This notion is predicated on the realisation that technology improves systems and systems improve productivity (Jost et al., 2016; Østerberg, Xiang, Olsen, Edenbrandt, Vedel, Christiansen & Palmgren, 2017). In the agricultural sector, the adoption of agricultural technology is viewed as a significant catalyst for improved operational performance (Sonwa, Dieye, El Mzouri, Majule, Mugabe, Omolo & Brooks, 2017; Aryal, Sapkota, Khurana, Khatri-Chhetri, Rahut & Jat, 2020). Through agricultural technology, farmers can manage costs and save money, which in turn helps them generate healthy revenues and profits from their farm output (Kaimowitz, Snyder & Engel, 2019). Some scholars believe adopting agricultural technology will improve farming practices and efficiency (Danso-Abbeam et al., 2017; Fuglie, Gautam, Goyal & Maloney, 2019). These benefits are primarily the result of adopting and implementing agricultural technology. Other scholars have also opined that farmers can increase their output by adopting new technology, resulting in financial and non-financial benefits (Kasirye, 2010). One of the main benefits in this regard is cost savings, increased profitability and operational efficiency.

2.2.2.3 Lower staple food prices

Another benefit of agricultural technology is the prices of staple foods. Researchers have found that agricultural technology increases crop yield, impacting farm produce supply to the markets (Meynard, Charrier, Le Bail, Magrini, Charlier & Messean, 2018; Zilberman, Yarkin & Heiman, 2018). The results of past studies support this viewpoint. For instance, Asfew et al. (2012) discovered that it is impossible to increase agricultural productivity without innovative agricultural technology. As a result, they believe that technological advancements are essential to increasing agricultural productivity to combat poverty, hunger, malnutrition, and high food prices and improve farm households' welfare. According to Wagan et al. (2018), agricultural growth with the ensuing rise in food productivity is a fundamental prerequisite for fair food prices from the perspective of developing nations. This school of thought is consistent with economic data that indicates that prices of goods decrease when the supply of those goods increases on the market. As agricultural technology improves productivity and increases harvest, the market's supply of basic foods soars, driving down food prices.

Also, farmers can produce large harvests through agricultural technology by improving crop varieties and production techniques, increasing the foodstuff supply (Senyolo, Long, Blok & Omta, 2018; Pathak, Brown & Best, 2019). This, in turn, results in low prices for staple foods, which helps to consolidate the efforts of governments to ensure food security (Pan et al., 2018).

2.2.2.4 Increase in earnings and eradication of poverty

The elimination of poverty is still a top priority for global development, and Sub-Saharan Africa continues to have the highest levels of food insecurity and undernutrition worldwide (Habtewold, 2021). This is because many of the world's poor are smallholder farmers who do not use modern agricultural technologies. According to Gassner, Harris, Mausch, Terheggen, Lopes, Finlayson and Dobie (2019), because poverty and hunger are unmistakably intertwined, the general opinion on the development of poorer nations holds smallholder farmers' agricultural output as the key to attaining the objectives of reducing poverty and providing food security. The World Bank defines poverty as a multifaceted notion that includes low income and consumption, poor educational performance, poor health and nutritional results, a lack of access to essential services, and an unsafe living environment (World Bank, 2018). As farmers implement agricultural technology that increases output, household well-being can be enhanced.

Furthermore, as agricultural production rises, national food security also rises. Food security refers to year-round access to a secure, sufficient food supply (Gassner et al., 2019). When technologies are successfully applied, the future effects can be seen in the performance of total economic growth and have a favourable impact on natural resources. Adnan, Nordin, and Abu Bakar (2017) acknowledged the necessity of successfully combining the advantages of agricultural technology with the nation's overall development goals and applying them to address socio-economic issues. This places a significant burden on the government to provide farmers with appropriate policies so they can gain significantly from adopting agricultural technologies.

Another benefit of agricultural technology is the increase in earnings. Through the adoption of agricultural technology, farmers can earn more from their produce through value addition (Michler et al., 2019; Thompson, Bir, Widmar & Mintert, 2019). Also, improved agricultural technology practices mean farmers can make better use of their land, further resulting in the diversification of production and an increase in yield (Pathak, Brown & Best, 2019). This positively impacts farmers' earning capacity and helps to alleviate poverty, especially in rural areas (Zheng, Wang & Wachenheim, 2018). This, in turn, impacts the quality of wages that farmers can pay their employees, which also helps reduce poverty. Jain et al. (2009) support this viewpoint as they discovered that a new technology for agriculture that improves sustainable food production is, therefore, essential for long-term food security and economic growth. Because of this, much research has been done on the mechanisms of technological developments in agriculture since the early 20th century.

2.2.2.5 Environmental conservation and sustainability

Adopting improved agricultural technology is regarded as an important benefit contributing to the preservation of the environment (Adnan, Nordin, Bahruddin & Tareq, 2019; Takahashi, Muraoka & Otsukaet, 2020). Through new knowledge and its application in agriculture, farmers and other stakeholders in the agricultural sector value chain can adopt sustainable practices which help to protect the environment from climate change and help to reduce bad agricultural practices which result in land degradation, erosion, and others (Chen & Ravallion, 2004; Jain et al., 2009). According to this viewpoint, farmers should encourage soil health, use less water, and reduce farm pollution. Consumers who care about sustainability, in turn, seek out food produced in an environmentally and socially responsible manner. For instance, advancements in agricultural technology led to the creation of green fertiliser technology (GFT), a contemporary sustainable agricultural development and ecologically friendly technology that aims to increase production levels across all crops. According to an empirical study, green fertiliser technology in rice cultivation produces one of the highest yields (Adnan et al., 2019). Three key goals are included in agricultural sustainability techniques. First, it aims for social and economic fairness, a healthy environment, and economic profitability.

2.2.3 Cost of agricultural technology

Acquiring agricultural technology is not as simple as it sounds (Michler et al., 2019). Like all technological adoption, there is a cost element which often hinders the adoption of new technology (Magruder, 2018; Ugochukwu & Phillips, 2018). In the case of smallholder farmers, acquiring agricultural technology is only made possible through a few feasible mediums (Wossen, Alene, Abdoulaye, Feleke, Rabbi & Manyong, 2019). These mediums are government grants, credit from banks and credit unions, and funding from cooperative societies (Michler et al., 2019; Manda et al., 2020). The cost of agricultural technology lies in the cost of acquiring these technologies and the cost of training, maintenance and renewal (Balana & Oyeyemi, 2020; Konja, 2022).

2.2.3.1 Cost of production materials

The total cost of all agricultural inputs used to cultivate a particular crop is the cost of production (Fausti & Wang, 2017). The cost of production then is the total price paid for inputs such as seeds, pesticides, herbicides, fertiliser, labour, insurance, machinery, land, and other chemicals, all of which have a monetary value. Due to the COVID-19 outbreak and the broader economic hardship brought on by the Russian-Ukrainian war, the cost of essential farming supplies has skyrocketed. Because of this condition, smallholder farmers are hesitant to employ farming technologies for fear of accruing debt (Atsriku, 2020). Some of these technologies need significant financial resources. For instance, using drone technology to apply pesticides, herbicides, and fertilisers to farms will cost vast amounts of money. For farmers, this technology offers enormous benefits. It only irrigates when necessary, using soil moisture sensors to conserve water and energy. It monitors factors like temperature, humidity, and leaf wetness to estimate the danger of disease or insect emergence for intelligent spraying, increases crop quality, and lowers labour costs. It employs temperature sensors to notify farmers of frost (Hafeez, Husain, Singh, Chauhan, Khan, Kumar, Chauhan & Soni, 2022). Although drone technology has many benefits for increasing farming operations, it is expensive for farmers. Fixed-wing agricultural drones with surveying capabilities might cost up to USD 25,000. The drone's features, such as its image sensors, software, payload, flying time, hardware, and equipment, can affect the price (Pathak, Kumar, Mohapatra & Gaikwad, 2020). The drone's projected price is GHc203,839.36, equivalent to a rice farmer's annual income for several years. Smallholder farmers in Ghana cannot afford this without access to bank loans. According to the Ghana Statistical Service (2022), Ghana's current inflation rate is 27.6 %. Because of the high inflation rate, agricultural inputs, including seeds, pesticides, herbicides, fertiliser, and labour, are becoming more expensive, making it difficult for smallholder farmers to invest in new technology (Baloch & Thapa, 2016).

2.2.3.2 Cost of credit acquisition

One of the main components of agricultural technology is the cost of credit acquisition (Cutler, 1991; Uslan, 1992). Scholars have found that smallholder farmers are often constrained by financing issues when adopting agricultural technology (Kulecho & Weatherhead, 2005; Cucho-Padin et al., 2020). This often results in a situation where these farmers depend on government grants and subsidies or donations from external funding agencies interested in agriculture (Jayne, Mather & Mghenyi, 2010). Most smallholder farmers are unable to finance the cost of new technology from their savings or investments because most of them have limited financial resources, as most of their income is spent catering for their family and also reinvesting in seeds and plantings for the new farming season (Mgbenka, Mbah & Ezeano, 2016). Adopting agricultural technology is usually considered a cost issue for smallholder farmers. They often view financial costs as the key element in the adoption process of technology (Mwangi & Kariuki, 2015). This reality has prompted scholars to advocate for financing options for smallholder farmers to facilitate the acquisition and ease of agricultural technology adoption (Fan, Brzeska, Keyzer & Halsema, 2013).

2.2.3.3 Cost of training

Another component of the cost of adopting agricultural technology is the cost of training (Stewart, Langer, De Silva, Muchiri, Zaranyika & Erasmus, 2015; Zhao et al., 2016). This refers to the costs incurred in educating smallholder farmers on the features, benefits and use of the technology (Mgendi, Mao, & Qiao, 2021; Phillip, Ernest, & Masa, 2022). The extant literature on technology adoption has been emphatic on the position that the adoption of new technology requires a process of knowledge acquisition and skill development in relation to the use of the technology (Evans & Samson, 2022). Training broadens farmers' perspectives, improves the necessary agricultural abilities, and boosts their understanding of technological advancements.

Smallholder farmers, therefore, need to be trained on the use of agricultural technology, and governments and other agricultural aid agencies often bear the cost of recruiting agricultural extension officers to educate and train smallholder farmers on the use of agricultural technology. The cost of training also includes training for staff or farm hands who work with smallholder farmers and district agricultural support officers who may be required to provide support services (Mgendi, Mao & Qiao, 2022). In order to ensure that the proper knowledge is applied to produce the best results from farming, agricultural extension officers act as a bridge between research and farmers. In addition, they facilitate and disseminate new ideas from research to farmers. According to Nakano, Tsusaka, Aida, and Pede (2018), training farmers is expensive; thus, it is crucial to think about training a small group who distribute agricultural technology skills, serve as a sort of proof-reader for the work of the farmers, and introduce new ideas and perspectives to farmers. The total cost of all these training programs aimed at boosting production through agricultural technologies is known as training cost. Due to the rising cost of training, many researchers are advocating farmer-to-farmer extension strategies that involve selecting lead farmers from the farming community and providing them with intensive training on production technologies, as this strategy provides a cost-effective option for technology dissemination (Nakano, Tsusaka, Aida, & Pede, 2018).

It is impossible to overstate the expense of farmer education. The Ghanaian government and the Millennium Challenge Corporation (MCC) of the United States of America inked a 5-year Compact (2006-2011) to teach farmers through farmer-based organisations. The training programme aims to boost the competitiveness of high-value cash and food crops in domestic and international markets and their production and productivity levels. This training program cost USD 547 million (ISSER Report, University of Ghana, 2012). Training farmers in the use of agricultural technology is expensive.

2.2.3.4 Cost of maintenance

Aside from the financial and training costs involved in acquiring agricultural technology, there is also the cost of maintenance (Tefera, Kanampiu, De Groote, Hellin, Mugo, Kimenhu & Banziger, 2011). Acquiring a technology also comes with the costs of maintaining and ensuring the technology is properly utilised and well-kept (Sennuga, Fadiji & Thaddeus, 2020). Even though some can classify maintenance as future costs, it is important to classify it as part of the cost of adopting agricultural technology (Stewart et al., 2016). In Africa, there have been accusations that smallholder farmers do not often have good maintenance cultures, resulting in the breakdown of equipment without regular servicing and repairs (Ainembabazi & Mugisha, 2014). This could be due to a failure on the part of financiers or trainers who may have been oblivious to the fact that aside from acquiring technology for smallholder farmers, there needs to be provision for maintenance or financial facilities available to cater for such costs with minimal or no interest rates. Therefore, maintenance is a high cost that smallholder farmers must be aware of.

2.2.3.5 Cost of renewal

The cost of renewal refers to the cost of replacing the technology with a new and better version when it becomes obsolete (Meijer, Catacutan, Sileshi, & Nieuwenhuis, 2015). Purchasing agricultural technology is expensive, let alone replacing it as it becomes dated. After the government implemented a policy of offering agricultural extension services to enhance agricultural production, Baloch and Thapa (2016) evaluated the impact of those services in Pakistan. Smallholder farmers are discovered to be unable to pay for the technologies. Therefore, the price of agricultural technology on its own becomes a barrier to adoption. After the acquisition of the technology, it sometimes wears out over time, and it is essential to factor in the renewal cost when educating smallholder farmers on adopting the technology (Mittal, 2012). Depreciation is an accounting phenomenon that accounts for the rate of wear and tear of equipment, gadgets and technology (Ologbon & Ambali, 2012). Therefore, it is essential for smallholder farmers to be aware of the lifespan of agricultural technology and know when expected renewal is due to happen so they can make provision for it.

2.2.3.6 Transaction cost

Any exchange between a buyer and a seller or any purchase made by a buyer from its supplier is a transaction (Schmidt & Wagner, 2019). Cost is related to transactions. Adopting agricultural technology involves transaction costs incurred while determining the best technology, negotiating with providers of new technologies, and enforcing contract performance. When a technology is adopted, there is a continuing need for information gathering and processing, contract and agreement drafting and negotiation, agreement monitoring and enforcement, and relationship management and maintenance.

Farmers who invest in technologies that improve farming operations for higher productivity suffer transaction costs. The base of transaction cost is the expense required to acquire improved production supplies, including seeds, herbicides, Fertilisers, and agricultural gear and equipment. However, ample evidence from the literature shows that price value can be a significant factor in customers' adoption decisions (Alam, Hoque, Hu & Barua, 2020; Dwivedi, Shareef, Simintiras & Weerakkody, 2016). Banks, for instance, are compensated for assisting farmers in importing machinery and equipment. High transaction costs may make adopting new technology unprofitable since they raise farmers' input costs (De Janvry, Emerick, Sadouley & Dar, 2016).

The above-discussed factors reveal the true cost of agricultural technology adoption. Furthermore, these factors suggest that financial cost is not the only consideration when evaluating the true cost of adopting agricultural technology. Based on these factors, it is clear that smallholder farmers will always be challenged to acquire and maintain this technology without continuous government support. These issues shall be addressed further in the policy implications section of this thesis.

2.3 TECHNOLOGY ADOPTION

Technology adoption refers to the various processes that consumers and organisations go through before becoming acquainted and familiar with new or existing technology (Kaur & Rampersad, 2018; Verkijika, 2018). The 21st century has witnessed an increasing rate of innovation, resulting in the development of new products, services, gadgets, agricultural seed varieties, equipment, and methods (Xu et al., 2007; Zelenika & Pearce, 2013). The extant literature reveals that the adoption of new technology often requires a period of adaptation from consumers (Liu et al., 2018). New technology requires new knowledge, orientation and behaviour, making technology adoption sometimes complicated for consumers (Edmondson, Bohmer & Pisano, 2001; Atuahene-Gima & Murray, 2007). According to Son and Han (2011), consumers have different attitudes, personalities and dispositions, which often translates into unpredictable behavioural patterns. This means that consumers are likely to respond differently to the introduction of new technology (Gera et al., 2020; Bhat, Bapat & Mookerjeeet, 2021).

Technology adoption is an important concept that has been examined critically over the years (Gaile-Sarkane, 2009; Kalantari, 2017) and represents a key component of this thesis. To understand and apply the concept of technology adoption to the agricultural sector in Ghana, this section offers insight into technology adoption by defining the phenomenon, examining the technology adoption process, and examining the determinants of technology adoption in general. From that point, the review examines factors facilitating the adoption of technology, as well as factors hindering the adoption of technology. Hooks et al. (2022) claim that technology adoption is a process influenced by many factors.

Nguyen (2009) also noted that technological adoption is often a complex process that entails identifying factors that could either hinder or enhance the decision of firms or consumers to embrace new technology. In today's dynamic world, the rate of technological advancement indicates that the issue of technology adoption is important and needs to be studied in more detail. This thesis intends to do that through this present investigation on technology adoption amongst smallholder farmers. The subsequent sections define technology adoption and examine the technology adoption process and factors facilitating and constraining the adoption of technology.

2.3.1 Defining technology adoption

Technology adoption can as well be referred to as the learning process and the cost involved in using new technology (Skare & Soriano, 2021; Stornelli, Ozcan & Simms, 2021). Over the years, the concept of technology has been explained in many different ways. However, the underlying factor is that new processes, methods, knowledge, devices, or a combination can be classified as technology. For example, Ragasa (2012, p.5) defined technology as "practices or techniques, tools or equipment, know-how and skills, or combinations of the aforementioned components." This suggests that technology adoption is the deliberate and conscious efforts made by individuals and organisations to embrace change by acquiring and using new practices, tools, equipment, knowledge, or a combination of these elements. Technology adoption is described as a planned activity because it does not happen by chance (Toufaily, Zalan & Dhaou, 2021; Su et al., 2021).

Some factors contribute towards the adoption of technology, and these shall be discussed in another section of this review.

Straub (2009) noted that technology adoption is a complex process. This view results from the many factors influencing an individual or organisation to adopt technology, whether old or new. An examination of the extant literature on technology adoption shows that some individuals are quick to adopt technology, whilst others dither and delay the process of technology adoption (Albort-Morant, Sanchis-Pedregosa & Paredes Paredes, 2022). In defining technology adoption, Straub's (2009) view needs to be put into perspective because adopting new technology is nothing short of complex. This complexity often refers to how easy or difficult it is for users to acquiesce and use the new technology (Lee, Xu, Porterfield, 2022). Straub (2009) further explained that technology adoption is a cognitive, emotional and contextual activity. This implies that the process of diffusing new technology needs to consider the effects of the technology on the cognitive, emotional and contextual situation of the target consumer.

Ghosh and Haque (2006) claim that technology adoption occurs sequentially. Their view is predicated on the notion that previous studies have pointed out that technology adoption has never been uniform in its manifestation (Ghosh & Haque, 2006). They claim that understanding technology adoption requires understanding the various factors which influence the adoption of technology by individuals. As a result, they asserted that adopting technology was a difficult and essentially social process, and this definition delineates the concept of technology adoption as a social process which implies that the adoption of technology by an individual or organisation will depend on social influence from friends or even rivals (Yang, Tang, Men & Zheng et al, 2021; Chopdar et al., 2022). Technology adoption can therefore be described as a complex social process that entails the various issues and considerations determining whether an individual adopts or rejects a technology (Featherman et al., 2021).

Defining technology adoption is often a tricky affair as most definitions tend to focus on the total acceptance and adoption of technology, failing to consider that, in some cases, technology adoption can mean the rejection of technology (Chadwick et al., 2022; Mergener & Trübner, 2022). It is not in all cases that technology adoption results in total adoption. Ghosh and Haque (2006) indeed averred that sometimes technology adoption could occur in sequences and stages, despite removing the most challenging barrier, which is often deemed the cost barrier.

This shows that adopting technology is a complex phenomenon, and it is no surprise that various empirical and theoretical studies have examined the phenomenon (Bae, Kwon & Bosley, 2020). Therefore, in this thesis, a proposed definition of technology adoption is given as follows:

"Technology adoption is the complex but deliberate process where individuals and organisations, based on their realisation of a need/gap, decide to acquire, learn and use new or existing technology as a means of improving output and efficiency within a defined context, and in spite of other prevailing challenges."

This definition incorporates various concepts, factors and descriptions from previous research and can guide other researchers to understand the nature of technology adoption.

2.3.2 Technology adoption process

Over the years, scholars have investigated the process through which consumers and organisations adopt technology (Kumar et al., 2018; Groher, Heitkamper & Umstatter, 2020). The technology adoption process is an issue of importance when it comes to understanding the nature and consequences of technology adoption (Sadoughi et al., 2020). In examining the technology adoption process, the extant literature reveals that there is no singular process which can be described as the technology adoption process (Kamble, Gunasekaran & Arha, 2019; Belk, Weijo, & Kozinets, 2021). Various frameworks and theoretical perspectives have been proposed over the years to explain the technology adoption process. For instance, the Diffusion of Innovation (DOI) theory is one of the widely respected theories on technology adoption that attempts to explain the technology adoption process. This framework has been attributed to Rogers (1995), who explained that for a technology to be accepted (adopted), it must first be diffused to the target audience. Rogers (1995) set about explaining the diffusion of innovations and is widely regarded as one of the thought leaders in the field of technology adoption.

From Roger's (1995) perspective, the technology adoption process can be classified into a sequential process where five categories of individuals demonstrate their capacity and willingness to adopt new technology. These individuals are innovators, early adopters, early majority, late majority, and laggards (Rogers, 1995). The diffusion process is the effort made by firms to communicate and create awareness about innovation among individuals in these five groups (Min et al., 2019; Oyelana, Kamanzi & Richter, 2021). Diffusing a technology is the act of ensuring that individuals are aware of the technology, know its benefits and have been educated on how to handle its challenges (Sasaki, 2018; Lee, 2021). Figure 2.1 presents the Diffusion of Innovation (DOI) theory which explains the adoption process from Roger's (1995) perspective.

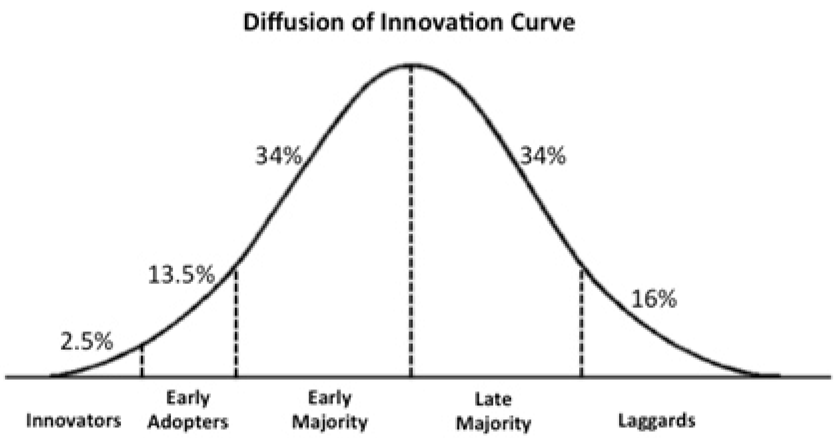


Figure 2. 1: Diffusion of Innovation Process

Source: Rogers (1995:11)

From Figure 2.1, Roger's (1995) DOI theory helps delineate the process of introducing and facilitating technology adoption amongst individuals with different characteristics and response rates. Innovators are classified as individuals who are quick to adopt new technology and often comprise just 2.5% of the total population. Laggards are the last group of consumers to adopt new technology and represent 16% of the total population. This indicates that the technology adoption process must be engineered to cater for the characteristics and needs of all these categories of consumers. Proponents of this theory assert that it is essential to diffuse the technology to make it appealing to all members of the population, from innovators to laggards. However, the consumer response rate is expected to vary in terms of adoption (Rogers, Havens & Cartano, 1962).

In the quest to further explain the process of technology adoption, some scholars proposed the Technology Acceptance Model (TAM), which essentially highlights the journey that consumers go through before adopting new technology which is predicated by two key factors, namely: Perceived Usefulness (PU) and Perceived Ease-of-Use (PEOU) (Awa, 2019). In addition, other theoretical perspectives have also sought to examine the technology adoption process, namely the Theory of Reasoned Action (TRA) and the Theory of Planned Behaviour (TPB), which both advance the argument that an individual's decision to adopt technology is dependent on their intention to perform the behaviour (adopting and using the technology), as confirmed by (Awa et al., 2017). These theories are discussed extensively in Chapter 3. Other scholars have also proposed the UTAUT as a technology acceptance model that demystifies the process of technology adoption by highlighting the behaviour that results in adoption, as influenced by performance expectancy, effort expectancy, social influence and facilitating conditions (Ronaghi & Forouharfar, 2020). This study supports the adoption of these theories in explaining the process of technology adoption amongst smallholder farmers.

2.3.3 Determinants of technology adoption

Some scholars have claimed that there are determinants of technology adoption which influence the decision to adopt or reject new technology (Feyisa, 2020; Dequanter, Fobelets, Steenhout, Gagnon, Bourbonnais, Rahimi & Gorus, 2022). These determinants include: Individual/Organisational Readiness, Access to Credit/Financing Options, Learning Orientation and Relevance of Technology. For example, scholars claim that individual and organisational readiness refers to the mental state of preparation and conditioning required to adopt new technology (Mwangi & Kariuki, 2015). Similarly, other scholars have found that access to credit or financing options can determine whether or not individuals or organisations will embrace technological change (Branca, Cacchiarelli, Haug, Sorrentino, 2022). The cost of acquiring new technology is an important determinant of technology adoption as it can either hinder or facilitate the adoption of new technology.

Some scholars have also alluded to the importance of a learning orientation to facilitate the adoption of new technology (Llewellyn & Brown, 2020). In addition, a learning orientation ensures that individuals and organisations will be ready to acquire new knowledge to facilitate the use of new technology (Kuivanen, Alvarez, Michalscheck, Adjei-Nsiah, Descheemaeker, Mellon-Bedi & Groot, 2016). Finally, the relevance of technology to individuals and organisations is another determinant of technology adoption. Several years of research confirm that individuals will only adopt technology they perceive to be relevant to their needs (Zeller, Diagne & Mataya, 1998). Perceived usefulness (PU) is the recognised term for describing the relevance of technology to individual needs (Caffaro, Cremasco, Roccato & Cavallo, 2020).

2.3.4 Factors facilitating the adoption of technology

The adoption of technology is precipitated by some factors (Kumar et al., 2018). Scholars have found that individuals and organisations do not just adopt new technology; some external or internal factors often determine whether or not technology will be embraced (Westin, Jansson & Nordlund, 2018; Chen, Rubens, Noel, Kester & Sovacool, 2020). These factors include access to information, access to credit and infrastructural support.

2.3.4.1 Access to information

One important factor facilitating technology adoption is access to information (Hennessy, 1996; Ullah et al., 2020). Information access is critical to the technology adoption process (Hobbs & Plunkett, 1999). This entails access via in-person education or dialogue from suppliers or the website and other sources of information (Aker, Ghosh & Burrel, 2016). When consumers have access to information regarding technology, it makes it easier for them to understand the technology's nature, features, benefits and challenges (Ogutu, Okello & Otieno, 2014).

2.3.4.2 Access to credit

The adoption of technology is not possible if there is a lack of credit (Awotide, Abdoulaye, Alene & Manyong, 2015). As such, access to credit is an important factor in facilitating technology adoption (Mohamed & Temu, 2008). Funding for technological adoption is a vital determinant of which kind of consumer can adopt technology (Motsoari et al., 2015). According to Rogers (1995), there are five adopter categories, and innovators may be the first to adopt new technology because they can afford it. Therefore, the cost of technology and access to credit is an important consideration for consumers in their decision-making process, which can result in adopting new technology.

2.3.4.3 Infrastructural support

Researchers have found that proper infrastructure also plays a key role in technology adoption (Feder et al., 1985). For example, a consumer will not acquire a 70-inch television when they do not have an apartment in the first place. The consumer will first acquire the apartment and then acquire the television. This applies to technology adoption because even in the case of organisations, scholars have found that it is essential to have the foundations and infrastructural support before acquiring new technology (Magruder, 2018). This is an important factor that also needs to be considered. Therefore, as far as this present study is concerned, adopting agricultural technology directly relates to the infrastructure available to smallholder farmers.

2.3.4.4 Behaviour of rivals

An interesting view found in the literature suggests that the behaviour of rivals can also influence the decision to adopt technology (Diederen, Van Meijil, Wolters & Bijak, 2003). Competitive reaction to technology adoption has become a common phenomenon as firms have sought to negative the competitive advantage rival firms stand to gain if they introduce or adopt a new technology to serve customers (West, 2020). This is common in the banking and telecommunications industry (Feder & Umali, 1993). The behaviour of competitors can facilitate the adoption of technology as a means of competitive response (Abebaw & Haile, 2013).

2.3.5 Factors constraining the adoption of technology

To effectively promote smallholder farmers' adoption of advanced agricultural technologies, it is necessary to identify the key barriers to the adoption. Limited access to information is considered the main obstacle. The probability of adopting new technology decreases significantly if farmers lack information about the benefits or how to use the technology correctly (Jack, 2013). This view has been confirmed by Ghosh and Haque (2006, p.157), who also claimed that "The lack of immediate and uniform adoption of new technological innovations has been attributed to factors such as lack of credit, limited access to information, aversion to risk and inadequate firm/farm size." This suggests that the factors constraining technology adoption can be categorised as limited access to information, lack of credit and attitude towards risk.

2.3.5.1 Limited access to information

One of the major obstacles to the adoption of technology is access to information (Asfaw et al., 2011). Connelly et al. (2011) have argued that information asymmetry is a barrier to the process of adoption and adaptation. The signalling theory has been used as a theoretical perspective to explain how access to information can influence decision-making outcomes (Zhao, Barry & Katchova, 2008). This study highlights limited access to information as one factor constraining technology adoption. When consumers lack information regarding technology, it hinders the various stages of the consumer decision-making process (Bulbulia, Fraser, Watts, Shaver & Gray, 2017). This often results in a non-purchase decision. It is, therefore, imperative for diffusers of technology to ensure that all portals where consumers can access information are supplied with the requisite information to facilitate consumer understanding of the technology.

2.3.5.2 Lack of credit

Another factor constraining technology adoption is the lack of credit (Neway, & Zegeye, 2022; Feyisa, 2020). Financing technology adoption is a discussion that scholars have extensively held over the years (Mishra, 2018). The consensus of scholars is that a lack of access to financing options or credit can hinder technology adoption (Balana & Oyeyemi, 2020). Indeed, some scholars have found that, in some instances, insurance companies offer special packages for consumers to be able to adopt new and relevant technology, such as wearable technology and smartwatches (Nakano & Magezi, 2020).

2.3.5.3 Attitude towards risk

Last but not least, attitude towards risk is another factor constraining the adoption of technology (Magruder, 2018; Feyisa, 2010). Some scholars have found that some individuals are risk-aversive (Hardaker, Lien, Anderson & Huirne, 2015), whilst others take risks and delight in exploring the unknown. It is clear from decades of scholarly investigations in technology adoption that individuals with a positive attitude towards risk will be able to adopt new technology faster than individuals with a negative attitude towards risk (Bernard, Bonein & Bougherara, 2020).

2.4 SMALLHOLDER FARMER AGRICULTURAL TECHNOLOGY ADOPTION (ATA) IN GHANA

This section examines agricultural technology adoption of by smallholder farmers in Ghana. This entails definitions of technology adoption, the status of ATA by smallholder farmers in Ghana, and determinants of ATA by smallholder farmers in Ghana. This section is relevant as scholars such as Doss (2006) opined that increasing agricultural yield and productivity can be achieved through adopting agricultural technology. This view has been reinforced by important stakeholders such as the World Bank, which has found that increased income for agricultural households can be achieved through the adoption of agricultural technology (World Bank, 2007). In addition, it has been noted that ATA is a viable strategy for combating poverty and improving the livelihood of smallholder farmers (Udry, 2011; Arslan, Wollni, Oduol & Hughes, 2022). Based on these propositions, the subsequent sections will discuss technology adoption concerning smallholder farmers in Ghana.

Technology adoption is an important concept that has been investigated significantly over the years (Qaim, 2017; Fuglie, 2018; Gao, 2021). The 21st century ushered in a technological revolution which has permeated every facet of society and human existence (Abate et al., 2016; Pray & Echeverria, 2019). In addition, innovations like the internet, production technology, social media, and other information communication technology developments have increased focus on technology adoption, its determinants and effects (Hazbavi & Silabi, 2021).

Owing to the importance of this concept in this thesis, it is important to offer some definitions of technology adoption for the purpose of clarity.

Some scholars have defined technology adoption as "…an integration of a new technology into existing practice and are usually proceeded by a period of 'trying' and some degree of adaptation" (Loevinsohn et al., 2013:3). This definition highlights the process of acquiring and integrating new technology into existing operational models to improve efficiency and performance. In addition, the definition also highlights the process of adapting to the new technology through testing and trial stages. Technology adoption can therefore be described as the process through which individuals or organisations acquire new technology, try the technology and include the technology in day-to-day activities and operations to maximise output and savings (Wossen et al., 2019; Manda et al., 2020).

The extant literature reveals that technology adoption varies from individual to individual and from firm to firm (Kumar et al., 2018; Miller, Griffin, Ciampitti & Sharda, 2019). Some scholars claim that adoption can be classified into two categories: (1) Rate of adoption and (2) Intensity of adoption. These scholars defined the rate of adoption as "…the relative speed with which farmers adopt an innovation, has as one of its pillars, the element of 'time'" (Bonabana-Wabbi, 2002:24). They also describe the intensity of adoption as "…the level of usage of a given technology in any time period" (Bonabana-Wabbi, 2002:24). In the agricultural sector, it has been argued that the adoption of technology depends on various factors (Zheng et al., 2018; Manda et al., 2020).

According to Marenya et al. (2014), when farmers accept innovations in technology, they not just assess the projected benefits but also evaluate the accessibility of those benefits throughout a range of future time periods. Based on this view, it can be argued that the adoption of technology can increase the present value of income being generated. The literature provides further evidence indicating that technology adoption is often facilitated by cost and benefit analysis, where the innovation/technology is adopted when farmers perceive it will benefit them (Omotilewa, Ricker-Gilbert & Ainembabazi, 2019).

2.4.1 Status of smallholder farmers ATA

The Ghanaian agricultural sector is the context of this study, and this section seeks to explore discussions in relation to the status of ATA by smallholder farmers in Ghana. The extant literature has documented some evidence regarding the status of ATA amongst smallholder farmers. The studies that exist in the field give the impression that "these technologies are particularly relevant to smallholder farmers in developing countries because they are constrained in many ways, which makes them a priority for development efforts" (Asravor, Boakye & Essuman, 2022). By reviewing the literature, it has been found that certain factors influence the adoption of agricultural technology by smallholder farmers (Ali et al., 2018; Danso-Abbeam, Dagunga & Ehiakpor, 2020).

Asravor (2020) investigated the adoption and intensity of mobile money usage amongst smallholder farmers in Ghana. They found that the age of the household head influenced the intensity of usage of mobile money services, higher educational level, marital status of the household head, household, and farm size, as well as the distance of the household heads from the mobile money agent which directly influences the intensity of use of mobile money services by household heads. Therefore, adopting this technology was helpful to smallholder farmers as it helped to facilitate payment to suppliers whilst also receiving money from trade partners, intermediaries and other supply chain partners.

Another study by Danso-Abbeam et al. (2020:1) also investigated the concept of "Rural non-farm income diversification and its implications on smallholder farmers' welfare and ATA in Ghana." In their study, these authors found that "non-farm income diversification increases the likelihood of *Zai-technology* adoption and contributes to significant household welfare gains." Zai-technology is a traditional method of managing soil restoration where organic materials are buried in a shallow pit to help the soil recover its fertility and retain water. Burkina Faso was where this technology was first created and popularised, from which it spread throughout West Africa. It is intended to restore degraded areas, preserve soil moisture, and boost agricultural productivity (Danso-Abbeam et al., 2020). This implies that the adoption of agricultural technology has a positive impact on household welfare and income.

Ali et al. (2018:1) examined the determinants of fertiliser adoption among smallholder cocoa farmers in the Western Region of Ghana and made the following profound comments.

> *"…the likelihood of Fertiliser adoption was influenced by factors such as farmers' engagement in off-farm economic activities, extension contacts, farm size, hired and family labour, and the value of productive farm assets. On the other hand, factors including household size, marital status, number of years working as a cocoa farmer (experience), support received from Non-Governmental Organizations (NGOs), farm size, and family labour significantly influence the extent of Fertiliser adoption. Therefore, improving extension services to farmers and encouraging the ownership of farm assets could be useful for fertilizer adoption".*

(Ali et al., 2018:1).

These findings confirm that adopting agricultural technology could positively affect smallholder farmers in Ghana. Other studies have been conducted from a Ghanaian perspective seeking to explore the phenomenon of ATA on the activities of smallholder farmers in Ghana (Ahmed & Anang, 2019; Teye & Quarshie, 2021; Konja, 2022). The findings of these various studies point to the fact that although certain constraints affect smallholder farmers in Ghana, adopting agricultural technology can be a panacea to some of the problems and challenges these farmers face. The findings further confirm that adopting agricultural technology could facilitate socio-economic development in rural communities in Ghana.

2.4.2 Possible determinants of ATA by smallholder farmers in Ghana

In this section, the researcher reviews literature relating to the determinants of ATA by smallholder farmers in Ghana. The factors facilitating the adoption of technologies and the factors constraining the adoption of the technologies will be discussed.

2.4.2.1 Possible ATA facilitating factors

In exploring the adoption of agricultural technology by smallholder farmers in Ghana, it is essential to consider the factors facilitating the adoption of these technologies. A review of the extant literature revealed that there are a number of factors that contribute towards the adoption of agricultural technology; these factors include access to credit, land ownership, ownership of prior agricultural technology and equipment, training and skills development, as well as perception (Ugochukwu & Phillips, 2018; Chavas & Nauges, 2020; Massresha, Lema, Neway & Deguet, 2021).

2.4.2.1.1 Access to credit

For farmers to be able to adopt agricultural technology, certain key factors need to be present. One of these factors is access to credit (Makate, Makate, Mutenje, Mango & Siziba, 2019; Nakano & Magezi, 2020). In agriculture, access to credit has long been heralded as an important factor which can improve outcomes in the agricultural sector (Manda et al., 2020). In this study, the researcher's position based on the literature review is that access to credit to fund and support the process of acquiring and adopting technological innovations in agriculture is key (Mariyono, 2018). This position is supported by scholars such as Tura et al. (2010), who, in their study, found that land ownership, access to credit, proximity to the nearest market and animal ownership all affect farmers’ decisions to use agricultural technology.

The authors also indicated that ATA significantly and positively affects farmers' income." The import of this finding is that access to credit plays a key role in the ability of farmers to access and use agricultural technology, innovations and systems. Without funding, it will be difficult for farmers to acquire new crop varieties, irrigation systems and other innovations to improve their output and income. Similar viewpoint was expressed by Kelsey (2013) who emphasised that the availability of credit plays a significant role in the adoption of new technology.

2.4.2.1.2 Land ownership

Another important and widely discussed factor that influences the adoption of agricultural technology is land ownership. According to scholars like Zeng et al. (2018), Manda et al. (2020), and Michler et al. (2019), land ownership is an important issue that can either help or hinder farmers in their quest to adopt agricultural technology. Often, it is the case that when farmers own or have the rights and title to the land they are farming on, it is easier to obtain help and access to credit via cooperative societies, banks and credit unions (Rola-Rubzen et al., 2020). However, the absence of land titles and deeds often complicates the process of adopting agricultural technology because it hinders the ability of the farmer to acquire credit to adopt the technology (Wossen et al., 2019).

2.4.2.1.3 Training and skills development

The adoption of agricultural technology also depends on the skills, expertise and level of education of the farmers (Azumah, Donkoh & Awuni, 2018; Kumar et al., 2018). According to a study conducted by Masresha et al. (2017) on the adoption of improved white haricot beans, it was found that training and skills development is essential in ATA. This represents a major policy issue for government and state agencies in charge of agriculture. A study by Masresha et al. (2017:355) found that "the decision to adopt white haricot beans variety was influenced by various factors. The study found that frequency of extension visits, land size allocated to haricot beans, agricultural income, price perception, training obtained, and perception on fertility enhancement benefit of the crop positively affected farmers' decision to adopt improved variety and distant to market, ownership of haricot beans farmland (tenure) and nutritional perception of the crop affected negatively." One other key findings that the study made was in relation to the training and development of farmers. Similar studies also established this, which found that training is key to adopting agricultural technology (Nakano, Tsusaka, Aida & Pede, 2018; Gao et al., 2020).

2.4.2.2 Possible ATA constraining factors

Sufficient evidence exists in the extant literature confirming certain factors hindering the adoption of agricultural technologies, especially in developing economies and countries (Doss & Morris, 2000; Knight et al., 2003; Knowler & Bradshaw, 2007). These studies reveal that the factors that hinder the adoption of agricultural technology can be classified as (i) socio-demographic factors, (ii) farm characteristics (iii) behavioural factors (Foster & Rosenzweig, 2010; Gars & Ward, 2019; Ruzzante et al., 2021). Socio-demographic factors refer to factors pertaining to income level, household size, and gender which often determine the adoption rate of agricultural technology (Alam et al., 2019).

Socio-demographic factors constraining ATA include household motivations, cultural norms and socialisation (Gasson & Errington, 1993; Lobley & Potter, 2004). Undoubtedly, it can be surmised that a household's motivation level can influence the decision to adopt new technology. Consumer behaviour studies have found that motivation is key to technology adoption (Sun & Gao, 2020; Mittal, Aggarwal & Mittal, 2020). The degree to which a consumer is enthusiastic and willing to use technology due to perceived benefits influences the decision to adopt or reject the technology (Budu, Seneadza, Entee, Fosu, Asare & Mensah, 2019; Bianchi, Tuzovic & Kuppelwieser, 2022). Smallholder household motivations are, therefore, factors affecting the decision to adopt agricultural technology. In every household, there are primary and secondary decision-makers. These influences, coupled with other factors such as economic factors, could act as constraints to adopting new technology by smallholder farmers (Neway, & Zegeye, 2022; Mugumaarhahama et al., 2021). Buyinza, Nuberg, Muthuri & Denton (2020) found that the motivation of smallholder farmers to adopt agroforestry was contingent on several factors. These factors included psychological factors such as social norms and existing cultural beliefs.

Cultural norms have also been identified as a socio-demographic factor hindering the adoption of new technology (Glover, Sumberg, Ton, Andersson & Badstue, 2019; Llewellyn & Brown, 2020). The culture of a people is an important factor that could also constrain the adoption of agricultural technology (Mwangi & Kariuki, 2015). Researchers have found some cultures prohibitive and unwelcoming to change and innovation (Perret & Stevens, 2006). This poses significant challenges in the quest to facilitate widespread ATA. Cultural norms can hinder ATA when these values and norms are inflexible and out of tune with modern reality (Muzari et al., 2012). Some cultures are progressive and view technology as a welcome addition to society, while others view technology as a threat to culture (Chinseu, Dougill & Stringer, 2019). These are some of the challenges that stakeholders in the agricultural sector must confront and resolve to ensure the progressive adoption of agricultural technology.

Another socio-demographic constraint in the adoption of agricultural technology is socialisation (Ngwira et al., 2014). A recent study by Buyinza et al. (2022) found compelling evidence which suggests that socialisation plays a key role in smallholder farmer ATA. In their study, Buyinza et al. (2020, p. 2199) revealed that "…the adoption behaviour of smallholder farmers is mainly shaped by existing community social norms and beliefs that tend to promote knowledge exchange, as opposed to the conventional knowledge transfer extension approaches. Norms are therefore an inherent part of social systems and can create distinct farming practices, habits and standards within a social group." This piece of evidence buttresses the point made by scholars such as Leta et al. (2018) and Zeweld et al. (2018), who claim that the orientation and socialisation of farmers impact their knowledge exchange capabilities and willingness to embrace new technology and the change that comes with it.

Hay and Pearce (2014) identified gender as another constraint hindering ATA in some communities where women-led agricultural households, there was a greater disposition towards new technology to increase agricultural production than in other households led by males (Hay & Pearce, 2014). This brings to the fore the issue of gender as a factor that could constrain the adoption of new technology in agriculture. Despite the obvious gender permutations and consequent implications for the adoption of agricultural technology, some researchers have found that gender, in some instances, also acts as an enabler in ATA (Chirwa, 2005; Khoza, de Beer, van Niekerk & Nemakonde, 2021). Ragasa (2012), in a review of gender and institutional dimensions of ATA, synthesised thirty-five (35) case studies and found that gender played a key role in ATA. That confirms the view of other scholars such as Hay and Pearce (2014) and suggests that assessing gender contribution to technology adoption could be key in determining how to overcome the constraints of gender roles on ATA amongst smallholder farmers in developing countries like Ghana.

According to Maertens and Barrett (2013), technological advancements – particularly in agriculture – drive long-term improvements in worker productivity, earnings, food availability, and overall economic development. The authors additionally contend that not all members of a population adopt new technology instantly, randomly, or fully. Therefore, any firm's economic understanding of the diffusion of new technology depends on understanding the dynamic and cross-sectional patterns of technology adoption. Reviewing the extant literature, access to credit is one of the glaring factors constraining the adoption of technology in agriculture. This is a major factor that often determines whether or not farmers can acquire and adopt new technology.
Scholars have formed a consensus that access to agricultural credit is probably one of the major challenges farmers face when adopting new technology (Sarker et al., 2020). It has been asserted that if farmers can find a good way to overcome

some financial obstacles, technology adoption will not be so difficult (Chandio, Jiang, Gessesse & Dunya, 2019; Carrer et al., 2020). Many studies have tried to establish the empirical relationship between credit and technology adoption and called for credit extension to rural areas where most of the farming population resides. For example, in a study to determine the impact of credit access on adopting agricultural technologies in Zanzibar, Tanzania, Mohamed and Temu (2008) regressed credit with some other factors in adopting agricultural technology using a switching regression model. The results revealed that access to credit, extension contacts, household size and value of productive assets significantly influence the adoption of agricultural technologies. In a similar study elsewhere in Africa, (Kudi et al., 2011) found that in addition to household (household size, level of education and yield) and institutional (contact with extension agents) variables, access to credit influenced the adoption of improved maize varieties.

Other studies, such as Donkoh et al. (2011), also applied the probit model to determine how socio-economic factors contribute to the adoption of Green Revolution technology in Ghana. The results revealed that the proportion of Green Revolution inputs is greater among households with formal education, higher levels of non-farm income, credit and labour supply, and those living in urban centres. Teklewold et al. (2013) applied multivariate and ordered probit models to determine the adoption of multiple sustainable agricultural practices (SAPs) in rural Ethiopia. The analysis showed that both the probability and the extent of adoption of SAPs are influenced by many factors, including credit constraints, a household's trust in government support, spouse education, rainfall and plot-level disturbances, household wealth, social capital and networks, labour availability, plot and market access.

Abdul-Hanan et al. (2014) also conducted a study on smallholder adoption of soil and water conservation (SWC) techniques in Ghana using the Poisson regression model. Results revealed that aside from credit, significant policy variables such as farm size, group membership and proximity to input sale points also positively influence the adoption of SWC techniques. In a related study, Bircan and De Haas

(2015) indicate that better access to bank credit can facilitate the diffusion of new technologies and production methods within emerging markets. However, the study further argued that without access to credit, production firms could remain stuck in a pattern of low productivity and weak growth.

Simtowe et al. (2006) also found that while access to credit increases adoption among credit-constrained households, it has no effect among unconstrained households. In addition, their results also show that factors that affect adoption among credit-constrained households are different from those that affect adoption among the unconstrained household. Recently, Shiferaw et al. (2015) used data from a household survey in seven groundnut growing districts to investigate the role of information, seed supply and credit constraints in conditioning technology uptake. Their results revealed that slow uptake is not mainly due to a lack of economic incentives but rather a reflection of information, seed supply and credit inefficiencies that prevent farmers from translating their desired demand into adopting modern varieties.

Another factor identified as a constraint for smallholder farmers in adopting technology is the location (Donkoh, 2020; Takahashi et al., 2020). Scholars have found that these farmers, for instance, live and farm in areas where rainfall is low and erratic and soils tend to be infertile. In addition, infrastructure and institutions such as irrigation, input and product markets, and credit and extension services are poorly developed (Muzari, Gatsi, & Muvhunzi, 2012). As such, these factors serve as a hindrance and a challenge that constrain farmers from adopting new technology. This is why government support is often required to ensure and facilitate ATA.

2.5 CHAPTER SUMMARY

This chapter reviewed literature pertaining to ATA by smallholder farmers. The chapter commenced with a discussion on agricultural technology, and the concept was defined and expounded based on a review of the extant literature. Having established an operational definition of agricultural technology, the chapter proceeded to discuss the types of agricultural technology. Different classifications were examined, including traditional agricultural technology and innovative agricultural technology. Also, other classifications of agricultural technology were discussed, along with factors influencing the adoption of agricultural technology. The currently available literature also outlined the benefits of agricultural technology, including enhanced crop varieties and harvest, increased farming productivity and cost savings, lower prices for basic foods, increased earnings and poverty eradication, environmental conservation, and sustainability. The cost of agricultural technologies was also made evident. Cost of production materials, credit acquisition, transactions, training, maintenance, and technology renewal are a few examples. This chapter further provided insight into the factors constraining the adoption of agricultural technology and the cost of agricultural technology. Finally, an empirical review of the literature was conducted, which also resulted in examining the literature on the adoption of agricultural technology by smallholder farmers in Ghana. Overall, this chapter has provided insight into the factors influencing ATA by smallholder farmers in Ghana. The next chapter expands on the strategies for consumer behaviour in the literature while concentrating on the study's theoretical framework.

CHAPTER THREE

TECHNOLOGY ADOPTION THEORETICAL FRAMEWORK

3.1 INTRODUCTION

This chapter examines the theoretical framework of the study, where various theories underpinning this thesis are presented. The chapter begins by discussing consumer purchase decisions, one of the important concepts related to this study. Factors influencing consumer behaviour in the agricultural sector are also deliberated, after which consumer behaviour strategies are discussed. From there, the chapter delves into a discourse on eight adoption theories before settling on the theoretical framework for this study which narrows down to three (3) main theories, namely: Technology Acceptance Model (TAM), Decomposed Theory of Planned Behaviour (DTPB) and the Diffusion of Innovation Theory (DOI). The chapter ends by providing an overview of the research setting, which serves as the context of the study. Overall, this chapter commits to delineating the various theories supporting the adoption of agricultural technology to establish the link between the postulations of the theories and the underlying relationships being explored in this study.

3.2 CONSUMER PURCHASE DECISION

Over the years, the literature on consumer behaviour has sought to examine various concepts and outcomes that pertain to the consumer. One of the important aspects is consumer purchase decisions (Foxall, 2001; Belk, 2005; Schiffman, O'Cass, Paladino & Carlson, 2013). Scholars have realised that a consumer's purchase decision is informed by many considerations, from the point of need recognition to the final purchase decision (do Paço, Shiel & Alves, 2019; Mehta, Saxena & Purohit, 2020; Nguyen & Johnson, 2020). Furthermore, consumers are complex beings influenced by internal and external factors (Di Talia, Simeone & Scarpato, 2019; Spangenberg & Lorek, 2019).

Consumers sometimes make rational decisions during purchases and, at other times, make decisions that defy established rational principles (Bangsa & Schlegelmilch, 2020; East et al., 2021). This highlights the vulnerability of consumers, especially in a digital age where multiple information outlets subject the consumer to the challenge of decoding and interpreting various messages from multiple sources and senders (Oghazi, Karlsson, Hellström & Hjort, 2018; Karimi, Holland, Papamichail, 2018). The Signalling Theory highlights the many influences consumers are subjected to and explains the process of decoding messages sent and offering final feedback, which may manifest as purchase decisions (Issok et al., 2018; Mou & Shin, 2018; Apostolidis & McLeay, 2019).

Consumer purchase decision, in a broad sense, can be defined as the final stage in the consumer decision-making process where the consumer affirmatively decides to choose a product or service to purchase, having been satisfied that the product will meet their needs and requirements (Anetoh, Nnabuko, Okolo & Anetoh, 2020; Koschnick & Hartman, 2020). At least three other stages precede the purchase decision stage: need recognition, information search and evaluation of alternatives (Shim et al., 2018; Mishra et al., 2021). The extant literature on consumer behaviour acknowledges that consumers go through various processes and mental exercises before making a final purchase decision (Qin, Peak & Prybutok, 2021; Ran, Lewis, Dawkins, Grah, Vanhuyse, Engström & Lambe, 2022). The trigger of a consumer's decision to acquire a product, service or brand stem from a recognised need that may result from assortment depletion or assortment extension (Schiffman, O'Cass, Paladimo & Carlson, 2013; Dahiya & Gayatri, 2018). The consumer decides what to purchase only after recognising that they may have run out of an existing product or require a new one (Pousttchi & Dehnert, 2018; Kim et al., 2021). After identifying this need, consumers begin a process of searching for information, either through online sources or through physical interaction with customer service representatives of brands or organisations (Faulds, Mangold, Raju & Valsalan, 2018; Islam & Chandrasekaran, 2020).

The process of information acquisition is essential in consumer decision-making and plays a major role in influencing consumer purchase decisions (Lv et al., 2018; Ansari et al., 2019; Lin, Featherman, Brooks, & Hajli, 2019). Consumers seldom acquire products that they have little knowledge of (Lee & Lin, 2021). Even though there are some instances of impulse buying on the part of consumers, their decision-making and eventual purchase decision is often viewed as a psychological process of identifying a need, acquiring information on various product alternatives, and evaluating these options to decipher the best choice in terms of product functionality and especially budget (Melumad et al., 2020; Santos & Gonçalves, 2021). Consumers are constrained by a lack of infinite resources. All consumers have limited resources, which implies that their purchase decision must consider factors such as product features, price, and other cognitive reinforcement boosters such as product warranty (Giri, Mondal & Maiti, 2018; Hosseini-Motlagh, Motlagh, Nematollaho & Nouri, 2018).

According to Song, Li, Li, and Li (2021:1), "When making a purchase decision, consumers often cannot make an in-depth evaluation of all available options and, as a result, often use a two-stage process to reach their decisions." This assertion pays credence to the earlier arguments that sought to convey the message that consumers do not just purchase products but make informed considerations based on evaluating alternatives or product options. Song et al. (2021) reveal that some consumers engage in a two-stage process prior to making a final purchase decision. This entails the consumer initially examining the various product alternatives available to solve the pending need before critically analysing these alternatives based on important factors such as product attributes. Some scholars note that most consumers often struggle to critically evaluate all options in-depth before making a final purchase decision (Zhang et al., 2017; Fan et al., 2020). It has been found that it is easy for a consumer to make purchase decisions regarding some products which are basic and inexpensive than other products which are complex and involve a higher financial obligation (Song et al., 2021).

Given the complexity of consumer decision-making and purchase decisions, some researchers proposed Decision Support Models, which seek to reduce the complexity involved in consumer purchase decisions (Schukert et al., 2015; Song et al., 2021). According to Haubl and Trifts (2000), Decision Support Systems are models that help consumers process information related to their intended purchase, which helps to improve the overall purchase decision. After the consumer has gone through the first three processes of the decision-making process, namely: need recognition, information search, and evaluation of alternatives, the next step is the purchase decision which entails making that final effort to exchange value for value as described by Kotler and Armstrong (2010). Kotler and Armstrong (2010) claim that the purchase decision is a stage in consumer decision-making where an exchange occurs between the consumer and a firm. The consumer exchanges value in the form of money (payable in various mediums such as credit or debit cards or even physical cash) and receive value in return in the form of the product.

The consumer decision-making process is an important consumer behaviour concept that helps explain the complexity consumers face when making purchase decisions. It is useful to note that this process entails five stages, each of which greatly influences the consumer's final purchase decision (Schiffman et al., 2013; Sahelices-Pinto et al., 2018). Scholars are keen to point out that there are many marketing implications for firms at each stage of the consumer decision-making process (Kotler & Armstrong, 2010; Chen, Nguyen, Klaus, & Wu, 2015), and this calls for firms to adopt the right strategies which can help guide consumers to making their product or brand the preferred choice. Keller (2013) stressed that consumers often tend to be confused and require help making decisions in a world of increasing brands and product options. Keller (2013) further explains that branding helps consumers by informing them of the source of a product, giving them a signal of quality, reducing search time and helping them to make an informed choice based on the history of the brand (Keller, 2013; Kotler & Keller, 2016). The consumer decision-making is presented in Figure 3.1 below.

Figure 3. 1: Consumer Decision-Making Process

Source**:** Dewey (1910).

From Figure 3.1, it is clear that there are different stages in the consumer decision-making process, culminating in the final purchase decision and post-purchase evaluation. In addition, as stated earlier, consumers undergo various psychological processes from the need recognition stage to the purchase decision stage and after (Wanke, 2008; Dhaliwal, Singh, & Paul, 2020). It is, therefore, important for marketers to understand the various stages in the consumer decision-making process and how each stage influences individuals' purchase decisions.

3.3 FACTORS INFLUENCING CONSUMER BEHAVIOUR IN THE AGRICULTURAL SECTOR

Consumer behaviour is a complex phenomenon that has been studied for decades, if not centuries (Trudel, 2019; Thøgersen, 2021). This has led to many empirical studies which have sought to identify and delineate the various factors influencing consumer behaviour (Mothersbaugh, Hawkins, Kleiser, Mothersbaugh, & Watson, 2020). This thesis specifically focuses on the factors influencing consumer behaviour in the agricultural sector. The agricultural sector is globally regarded as important to the economy and human existence (Cranfield, 2020; Taghikhah, Voinov, Shukla, & Filatova, 2020). Furthermore, the issue of food security is an important policy consideration for many governments, and this has resulted in significant investment and Research and Development (R&D) funding for firms and institutions in the agricultural sector (Adnan et al., 2019).

From a consumer behaviour stand, many manufacturers of Fast-Moving Consumer Goods (FMCGs) are also keen on consumer behaviour practices because they recognise that consumers are influenced by certain factors which culminate in their decision to accept or reject a product or innovation (Groening et al., 2018; Sharma, 2021). This chapter examines the factors that influence consumer behaviour in the agricultural sector. A review of the extant literature reveals that some of the factors influencing consumer behaviour in the agricultural sector include: cultural factors, social factors, personal factors and psychological factors (Schiffman & Kanuk, 2007; Hervé & Mullet, 2009; Diallo et al., 2013).

3.3.1 Cultural factors

Consumers are defined by their culture, which constitutes an important part of their identity (Schiffman et al., 2013; Foxall, 2014). Cultural factors significantly influence consumer behaviour and can determine how consumers respond to products and marketing communications (Goodrich & De Mooij, 2014). Over the years, consumer behaviour researchers have tried to establish the link between culture and consumer behaviour. They have concluded that culture is an important factor that influences consumer actions (Kotler & Armstrong, 2010). Based on the agricultural sector, it can be theorised that culture plays a significant role in ATA and agricultural practices in general. Evidence from the extant literature points to cultural norms shaping individuals and determining their worldview and response to environmental stimuli (Kim & Yoon, 2021; Kakkar & Chitrao, 2022). Culture can be an enabler of technological adoption or a hindrance (Sunny, Patrick, & Rob, 2019; Huang, Sánchez–Prieto, Teo, García–Peñalvo, Olmos–Migueláñez, & Zhao, 2021).

In the agricultural sector, culture represents an important consideration that stakeholders must consider. According to Curry, Nake, Koczberski, Oswald, Rafflegeau, Lummani and Nailina (2021), socio-cultural factors influence technology adoption in agriculture. Individuals' culture, customs and outlook on life can influence their agricultural practices (Siegrist & Hartmann, 2020). Agricultural practices and technology have been passed down from generation to generation, and in some cases, certain practices have come to be accepted as cultural heritage (Pathak et al., 2019). This can often result in developing a pessimistic and apprehensive attitude towards agricultural innovation, which must be considered critically. Culture influences farmers' decisions and other key players in the agricultural value chain (Verma & Sinha, 2018). This implies that certain agricultural practices are influenced by culture, and this could pose a threat to any new agricultural technology that may seek to render such sacred practices obsolete (Adnan et al., 2019).

Understanding the influence of culture in the agricultural sector has been deemed important to the successful implementation of modern farming practices (Adnan et al., 2019; Barnes, Soto, Eory, Beck, Balafoutis, Sánchez, & Gómez–Barbero, 2019). In addition, the agricultural sector is considered one of the important sectors in the global economy. With globalisation and technological innovation taking precedence in today's world, it is safe to aver that assimilation and adaptation of culture could be vital in influencing consumer behaviour in the agricultural sector. Similarly, in the value chain process, marketers can consider the influence of culture and develop unique packaging and branding influenced by culture, which can appeal to indigenes and the global market (Schiffman et al., 2013; Kotler & Armstrong, 2010). Similarly, the role of culture must be considered when developing new products and innovations pertaining to equipment and tools for farmers. Culture has a huge influence on consumer behaviour, and this is true even in the agricultural sector.

3.3.2 Social factors

Social factors have been identified as another factor influencing consumer behaviour (Schiffman et al., 2013; Lin et al., 2019). For years, marketers have discussed social roles, family influences and social networks and their impact on consumer behaviour (Hanaysha, 2018). The general consensus identified in the consumer behaviour literature is that social factors greatly affect consumer behaviour and influence certain behavioural intentions (Nash, 2018). In the agricultural sector, social factors also influence the approach to farming and other Agric-related activities (Adnan et al., 2019; Cranfield, 2020). For example, peer influence from colleague farmers and opinion leaders in the community affects the decision-making of farmers and entrepreneurs in the agricultural sector (Kante et al., 2018; Sutherland & Marchand, 2021). Over the years, social factors have been recognised as important in explaining why consumers take certain decisions with respect to agricultural products (Rust, Stankovics, Jarvis, Morris–Trainor, de Vries, Ingram, & Reed, 2022). Similarly, some scholars have found that farmers also tend to take certain decisions based on social pressure and suggestions from friends and family (O'Connor, Meredith, McNamara, O'Hora, & Kinsella, 2021; Rust et al., 2022).

3.3.3 Personal factors

Personal factors such as age, occupation, lifestyle, and personality affect consumer behaviour (Schiffman & Kanuk, 2007; Schiffman et al., 2013). The extant literature reveals that personal factors impact the behaviour of consumers in the agricultural sector (Steenkamp, 1997). For example, consumers are impacted by their age, allowing them to consume or refrain from consuming certain agricultural products (Rana & Paul, 2017). At a certain age, medical experts and doctors advise individuals only to consume certain types of food (Willet, Skerrett, & Giovannucci, 2017). This affects the behaviour of consumers and results in demand for a certain category of foods, especially fruits and vegetables (Gough & Connor, 2006). Consequently, as demand for such products increases, the viability of growing such produce increases, and farmers can make more sales by meeting the demands of a growing target market (Holm, 2003).

Occupation is another important personal factor influencing consumer behaviour in the agricultural sector. Individuals in the working class tend to consume food in high volumes, especially individuals with families and living in large family homes with many siblings and relatives (Schiffman et al., 2013). Occupation similarly determines the level of disposable income available to purchase agricultural products and the type of food individuals will consume (Fraj & Martinez, 2007). Individuals' personalities and lifestyles also impact consumer behaviour in the agricultural sector. For example, individuals in the upper and middle classes tend to prefer dining in expensive restaurants. In such cases, demand for special foods increases, as can be witnessed in the case of foods such as caviar, shrimp and sea-food-related dishes. This determines the kind of various farmers and Agri-based entrepreneurs invest in (Mangnus, 2019). In addition, personal factors can help to determine pricing, packaging and other considerations in the agricultural sector (Schiffman et al., 2013).

3.3.4 Psychological factors

Psychological factors include motivation, perception, learning, beliefs and attitudes (Schiffman & Kanuk, 2007). These prominent consumer behaviour factors impact individuals' and groups' behaviour (Schiffman & Kanuk, 2013). Motivation determines the consumption pattern of consumers in the agricultural sector. According to Schiffman and Kanuk (2007), motivation is an internal feeling which often stimulates the desire for certain products/services. Motivation drives consumers to recognise their needs and find solutions or alternatives to satisfy them (Thilmany et al., 2008). Motivation also refers to strong internal stimuli that influence consumers to take certain actions to achieve specific goals (Daugherty et al., 2008). Motivation can determine the foods consumers crave, which has several implications for the agricultural sector (Janssen, Busch, Rödiger, 2016). Consumer perception can also determine the kind of food produced to patronise, with a typical example being the challenge of getting Ghanaian consumers to adopt Made in Ghana Rice products (Coffie, 2015). The dominant beliefs and attitudes of the consumer influence their behaviour and demand for agricultural produce (Rödiger & Hamm, 2015). Similarly, the attitude of farmers and motivation can determine the level of technological adoption, which can result in the patronage of new varieties of crops, new equipment, and packaging of final products, to name a few (Beckline & Kato, 2014).

3.4 CONSUMER BEHAVIOUR STRATEGIES

Consumer behaviour strategies are the various mechanisms firms and marketing strategists use to influence consumer behaviour, especially their purchase patterns and decisions (Yan & Ke, 2018; Rambabu & Porika, 2020). Over the years, marketing strategists have sought to determine effective strategies for predicting and influencing consumer behaviour to elicit desired outcomes (do Paço et al., 2019). A review of the extant literature identifies consumer behaviour strategies such as pricing, packaging, promotion, and branding (Schiffman & Kanuk, 2007; Kotler & Armstrong, 2010; Keller, 2013).

3.4.1 Pricing

One of the strategies for influencing consumer behaviour is pricing (Ahmetoglu et al., 2014; Rödiger & Hamm, 2015). Pricing is an important consumer behaviour strategy because it determines the demand for a product and can influence the revenue firms are able to generate (Yeoman et al., 2017). Consumer behaviour strategists also claim that pricing can influence the perception of products, with luxury goods often commanding higher prices than normal goods with no positioning or strategic branding (Dhaliwal et al., 2020). Firms use strategic pricing to influence consumers. This is evident during seasonal sales, where firms offer percentage discounts for certain products, with the view to driving volumes through a reduction in price (Oliveira-Castro et al., 2005). The enthusiastic response of most consumers to sales and promotions confirms that pricing is one of the effective consumer behaviour strategies (Husnain et al., 2019). Kotler and

Armstrong (2010) claim that pricing is one of the elements of a firm's marketing mix, which can be used to generate revenue.

3.4.2 Packaging

Visual stimuli influence consumers, and for decades, marketers have sought to influence consumer behaviour through attractive packaging (Kotler & Armstrong, 2010). Yokokawa et al. (2018) revealed that consumers are influenced by the design of packages and can choose to either accept or reject a product/brand because of good or bad packaging. Other scholars like Wikström et al. (2014) also observed that packaging design is an important consumer behaviour strategy which firms can use to stimulate demand for a product. Coca-Cola, in particular, has been very adept at leveraging unique packaging to influence consumer behaviour (Khan & Lee, 2020). Other brands have also been strategic in deploying unique packaging, which has been found to influence consumer perception of product quality and eventual purchase decisions (Festila & Chrysochou, 2018). Packaging undoubtedly is one of the consumer behaviour strategies which is deployed to great effect in stimulating consumer demand and influencing consumer response to products and brands.

3.4.3 Promotion

One of the effective consumer behaviour strategies is promotion. Kotler and Armstrong (2010) define promotion as the strategic act of creating awareness. Promotion is one of the elements of the 4 P's of the marketing mix. It is executed through advertisements, personal selling, marketing campaigns and other exciting activities, such as experiential marketing events, which are geared towards creating product awareness and influencing consumer behaviour towards outcomes such as purchase decisions, loyalty and referrals (Keller, 2013; Misra & Kanda, 2019). In addition, promotion effectively informs consumers of the products and services of firms and helps consumers acquire useful knowledge and information during the decision-making process (Schiffman & Kanuk, 2007; Kotler & Armstrong, 2010).

3.4.4 Branding

Branding is the act of endowing a product, service, idea or place with a unique identity that can distinguish it from competing products on the market (Keller, 2008; Keller, 2013). Branding is a consumer behaviour strategy used to generate revenue for firms by presenting products as value-added offerings that influence the emotions of consumers and create a connection that results in life-long patronage and consumption (Keller, 2013; Pinson & Brosdahl, 2014). Branding is used to create products that consumers want to patronise and stay loyal to (Keller, 2013). Consumers have been identified as being affected by product uncertainty, and branding is a strategy used to reduce risk uncertainty and build trust in a manufacturer's product (Schiffman & Kanuk, 2007). Consumers have, over the years, developed an affinity for specific brands and patronised them irrespective of where they are in the world (Kotler & Armstrong, 2010). This confirms the potency of branding as one of the effective consumer behaviour strategies.

3.5 ADOPTION THEORIES

This thesis aims to explore ATA amongst smallholder farmers. To achieve this aim, it is imperative to discuss adoption theories propounded over the years and widely used in discussions on technology adoption. Therefore, this section discusses eight (8) adoption theories, namely: Diffusion of Innovation Theory (DOI), Social Cognitive Theory (SCT), Theory of Reasoned Action (TRA), Theory of Planned Behaviour (TPB), Decomposed Theory of Planned Behaviour, Technology Acceptance Model (TAM), Revised Technology Acceptance Model (TAM 2), and Augmented Technology Acceptance Model (A-TAM).

3.5.1 Diffusion of Innovation Theory

The Diffusion of Innovation Theory (DoIT) is widely accepted for studying consumer behaviour (Ratts & Wood, 2011; Curtis, 2020). This theory has been cited severally by scholars as it helps explain the processes consumers go through before adopting an innovation (Valente & Rogers, 1995; Rogers et al., 2014).

3.5.1.1 History of DoIT

The Diffusion of Innovation Theory (DoIT) has been credited to Everett Rogers (Rogers, 1962). Rogers (1962) propounded this theory which sought to explain how innovation is developed over time and the process consumers go through before finally adopting an innovation. According to Rogers (1962; 2003), the diffusion of innovation theory emerged to help explain the role of innovation in society while offering some insight into the characteristics of innovation and some factors that determine an individual's intention to adopt a new product. It has been reported that the DoIT is one of the oldest theories used in the social sciences to explain innovation and its related consequences (Rogers, 2002; Rogers, 2003; Rogers et al., 2014).

3.5.1.2 Assumptions of the DoIT

Rogers (1962) explained that DoIT could be used to identify how innovation is transmitted into society and the several stages of adoption that occur over time owing to the difference in consumer characteristics. The main assumption of the Diffusion of Innovation Theory is that it takes time for new ideas, products, and innovations to be accepted by people (Rogers 1962; 2003). Rogers (2003) further explained that to get an innovation to be adopted by people, an effective communication strategy needs to be developed. This is anchored on the premise that individuals have different idiosyncrasies and cultural influences, which may hinder or facilitate the adoption of innovations (Schiffman & Kanuk, 2007; Schiffman et al., 2013). As such, the theory highlights the important role of diffusion in ensuring that innovation has a high success rate.

According to Rogers (1962), diffusion can be defined as a conscious and deliberate attempt to communicate an innovation using diverse media channels to stimulate acceptance and adoption. DoIT posits that diffusion is instrumental in determining an innovation's success; without it, low adoption rates are likely to occur (Ali et al., 2019; Min et al., 2019). Rogers (2003) also acknowledged that communication is essential in the process of diffusion because it transfers information from the creators of innovations to the target audience, and successful diffusion helps to avoid information symmetry which can be described as a barrier to adoption. DoIT further advances that diversity in society requires the process of diffusion to be clear and intentional in promoting messages that cut across social and cultural barriers in order to reach members within the community and convince them of the merits of adopting the new innovation (Rogers, 1962; Murray, 2009).

Another key assumption of DoIT is that people need to understand innovation and be convinced of its benefits before adopting it (Rogers, 1962; 2003). Therefore, DoIT has been labelled as a social and psychological theory that seeks to understand the nature of individual behavioural patterns in order to facilitate the successful diffusion of innovations (Rogers, 2003). In order to do this, it is important to determine the characteristics of consumers in order to understand how an innovation is likely to be received. As a result, some scholars (See Rogers, 2003; Schiffman & Kanuk, 2007) have identified five (5) adopter categories which include: (1) Innovators, (2) Early Adopters, (3) Early Majority, (4) Late Majority and (5) Laggards. These adopter categories help explain individuals' characteristics and how that influences their willingness and speed of adoption.

Innovators are individuals who are enthusiastic about innovations and are always eager to try new things out (Rogers, 1962). Early adopters are individuals who perceive themselves as leaders and always want to explore new possibilities, reflecting their consumption of new ideas, products and innovations (Rogers, 2003; Schiffman & Kanuk, 2007). The Early Majority can be described as a group of consumers who are not leaders or trendsetters but more willing than the ordinary consumer to embrace risk and try new innovations, especially when they have seen evidence of its benefits (Rogers, 2003). On the contrary, the Late Majority refers to the group of risk-averse consumers who are also slow to embrace change (Rogers, 2003; Schiffman & Kanuk, 2007). Such consumers only adopt innovations after they have been convinced that most individuals have embraced the innovation and it has a positive impact on their lives (Kotler & Armstrong, 2010).

Finally, the Laggards are the last group of consumers to embrace innovations and usually take a long time before accepting change (Rogers, 2003). These consumers have been observed to be conservative and laid back when trying new things and embracing change (Schiffman & Kanuk, 2007; Pathak et al., 2019). Unsurprisingly, they are the last group of individuals to adopt innovations. Therefore, it is important to understand the dynamics of the various consumer groups to see how these characteristics facilitate the adoption or rejection of innovations. In further advancing DoIT, Rogers and Shoemaker (1983) posit that understanding the adoption patterns of individuals is vital to creating effective diffusion strategies to stimulate adoption amongst consumers.

3.5.1.3 Components of the Theory

According to Rogers (2003:12), “An innovation is an idea, practice, or project that is perceived as new by an individual or other unit of adoption.” Rogers (1995:212) identified five (5) characteristics of innovations which are presented as antecedents of adoption. These five characteristics of innovations are discussed below.

3.5.1.3.1 Relative advantage (RA)

Relative advantage, as a characteristic of innovation, refers to the extent to which an innovation offers more comparative advantage than a previous version (Rogers & Shoemaker, 1971; Park, 2019). Lin and Chen (2012) noted that innovations gain acceptance when consumers perceive the new technology or product to offer them better functionality than previous models. Relative advantage as a characteristic of innovations, therefore, refers to the ability of an innovation to offer better features, functionality and effectiveness than previous versions (Rogers, 2003).

3.5.1.3.2 Compatibility

Compatibility in the context of DoIT refers to the extent to which an innovation achieves congruity with the values, beliefs and lifestyle of consumers (Rogers, 1995; Min et al., 2019; Ali et al., 2019). According to Rogers et al. (2014), compatibility is the degree to which a technology or product enhances the lifestyle of the consumer without much difficulty. It examines the level of fit between the consumer and the innovation (Rogers, 2003). Some scholars have opined that compatibility is key in determining the perceived usefulness and perceived ease of use of an innovation (Rogers et al., 2014). Existing studies confirm this notion, further suggesting that for an innovation to be successful and achieve high adoption rates, it needs to be compatible with the target market (Zhang, Guo, & Chen, 2008; Rogers et al., 2014).

3.5.1.3.3 Complexity

Complexity is a feature of innovations that examines the level of difficulty consumers may have when adopting and using the technology (Rogers, 1995; Rogers & Shoemaker, 1971). According to scholars, when innovations are complex and difficult to understand, the natural consequence is low adoption (Yuen et al., 2021). Consumers do not want to entangle their lives with difficult things, including technology and products (Peshin et al., 2019). Therefore, consumers often reject such innovations that do not come across as easy to use. Some scholars believe that the presence of complexity in an innovation may dissuade consumers from even attempting to learn and understand the innovation (Rogers, 2003; Rogers et al., 2014). This will certainly affect their behavioural intentions, especially to adopt and use the technology. Some researchers have established a link between complexity as a component of the DoIT and Perceived Ease of Use (PEOU) from the Technology Acceptance Model (TAM). Moore and Benbasat (1991), for example, stated that complexity features in DoIT as one of the five features of innovations, whilst PEOU is conceptualised as one of the salient beliefs in addition to Perceived Usefulness (PU) when adopting new technology.

3.5.1.3.4 Observability

Another important characteristic of innovations, as propounded by DoIT, is observability. Rogers (2003) explains that observability refers to the extent to which innovations are conspicuous to the target group. Rogers (2003) postulates that consumers are more willing to adopt innovations when they can see its benefits. Innovations which cannot convey their benefits to consumers will suffer from low adoption rates (Schiffman & Kanuk, 2007; Schiffman et al., 2013). Therefore, visibility of functionality and benefit is a key characteristic of innovations that firms must consider while creating and diffusing innovation.

3.5.1.3.5 Social influence

Social influence refers to how an individual’s family, friends or social affiliates influence each other’s behaviour (Kulviwat et al., 2009). Social influence is important in adopting innovations, as close family and friends can have an important say in a consumer’s decision to adopt or reject an innovation (Risselada et al., 2013). Schiffman and Kanuk (2013) claim that social influence can sometimes be more effective than advertisements. Ohnemus (2009) claimed that consumers chose brands they trusted and recommended by friends. Kotler and Armstrong (2010) also noted that individuals in the social circle of a consumer could sway a purchase decision towards a favoured brand. Moreover, Word of

Mouth (WOM) communication has unsurprisingly become an important factor influencing consumer behaviour (Eckhardt et al., 2009; Talukder & Quazi, 2011).

Rogers (2003) observed that social influence could play an important role in a consumer's decision to either adopt or reject an innovation. This view was corroborated by Young (2009), who found that individuals are more likely to move towards innovation and consider purchasing when other members of their social circle or reference group have adopted the innovation and are reaping the rewards and benefits. Other scholars, such as Koenig-Lewis et al. (2015), have found that social influence effectively stimulates adoption intentions because it reduces the risk associated with innovations and leverages social ties and networks to reassure consumers of the merits of adopting an innovation.

3.5.1.4 Criticisms of DoIT

Despite its wide acclaim and acceptance, some scholars have pointed out some flaws and criticisms of DoIT. Min et al. (2019) offered some perspective on these perceived flaws. Rogers (2002) described diffusion as a deliberate attempt to stimulate the adoption of technology by creating communication messages in the forms of advertisements and infomercials, to name a few, which discuss or highlight the unique features of the innovation. Innovation is largely considered a social phenomenon. Yet, Min et al. (2019) claim that aside from social influence, the five innovation characteristics were silent on the role of social factors in influencing consumer behaviour. Other criticisms of the theory include the fact that it didn't look at potential obstacles to innovation adoption or the role and impact of culture on technology adoption (Sarker & Wells, 2003). Lastly, Min et al. (2019) claim that the DoIT does not consider the role of individual resources in adopting new technology.

3.5.2 Social Cognitive Theory (SCT)

The Social Cognitive Theory (SCT) is another important theory whose assumptions and postulations have some meaning and impact for constructing arguments in this thesis on smallholder farmers' adoption of agricultural technology. The theory is examined in further detail in the following sections.

3.5.2.1 History of the social cognitive theory

The Social Cognitive Theory (SCT) is attributed to the work of Bandura (1986). A review of the extant literature reveals that the SCT was originally known as the Social Learning Theory (SLT), a theory propounded by Albert Bandura in the 1960s (Bandura, 1986; 2001). However, the SLT evolved and became known as the SCT through the work of Bandura (1986). The theory posits that individuals learn through interaction with their environment (Bandura, 1986). The SCT focuses on how individuals learn and maintain behaviour by evaluating their environment and personal characteristics (Bandura, 2001). The theory also helps explain how individuals connect their past experiences with present behaviour, which is crucial in exploring adoption, as has been explained by other theoretical perspectives such as DoIT and the TAM.

3.5.2.2 Assumptions of the social cognitive theory

The SCT posits that human beings have control over the quality of their life (Bandura, 1989). According to Bandura (1989), individuals can learn by examining past experiences and replicating certain behavioural patterns based on certain cognitive factors. Schunk and DiBenedetto (2020, p.2) also claim that “A central premise of Bandura’s theory is that individuals strive for a sense of agency, or the belief that they can exert a large degree of influence over important events in their lives. They exercise this sense of agency using their cognitive and self-regulative capabilities such as by setting goals and implementing strategies to attain them. They monitor their progress toward their goals and adjust their strategies as they believe is needed." This approach helps clarify Bandura's (1989) concept of learning. The social cognitive theory claims that people can learn from their past experiences and environment, which can shape future behaviour.

Another assumption championed by the SCT is that individuals can set and achieve certain goals, a term described as "self-efficacy" (Bandura, 1977). Self-efficacy essentially postulates that individuals have control over their behaviour and are not powerless to initiate change (Bandura, 1997; Schunk & DiBeneditto, 2020). Self-efficacy has been described as an outcome of self-reflection, which results in an individual developing the capacity to be evaluative and goal-directed (Bandura, 1997). The social cognitive theory argues that individuals can exert human agency. This concept is similar to an agency in corporate governance, only that in this case, individuals assume responsibility for their actions and are able to initiate actions that can improve the quality of their lives (Bandura, 2002).

3.5.2.3 Components of the social cognitive theory

The social cognitive theory propounded by Bandura (1986) posits that individuals can learn within a defined social context through interaction between the individual, their environment and their behaviour. Scholars (See Bandura, 2009) have, as a result of this postulation, identified three (3) main components of the SCT, which are (1) The Environment, (2) Personal Factors and (3) Behavioural Outcomes. For learning to occur, Bandura (2012) hints that an individual needs to evaluate self and the environment and identify a desired behavioural outcome. The SCT magnifies the role of the environment as a major component in influencing behaviour. The individual's interaction with the environment is crucial to shaping their present and future behaviour whilst meaningfully preserving past experiences (Wood & Bandura, 1989).

Other studies have sought to further break down the components of SCT into smaller factors. For example, Bandura (2012) suggested that personal factors could be classified according to gender, age, occupation and beliefs, which are essential components influencing an individual's ability to evaluate the forces in the external environment. In addition, Biraglia and Kadile (2016, p. 3) claim that "cognitive competencies and emotional states, in particular, can play an important role in recognizing environmental clues and making decision to engage in specific behaviours". The SCT also focuses on the role of goals in achieving desired behaviour by enabling individuals to harness their efforts towards achieving certain desired outcomes (Bandura, 1986). According to Bandura (1986; 1997), the Socio-Cognitive Causal structure has been identified as an effective model for promoting desired behaviours. This structure argues that self-efficacy, barriers, outcome expectations, goal-setting, planning, social support and functional limitations are all important factors that must be considered when seeking to initiate behaviour change (Bandura, 2004).

3.5.2.4 Criticisms of the theory

Some criticisms have been levelled at the SCT, with critics pointing out a number of limitations with this theory (Stacey et al., 2015). One of the major criticisms of the SCT is that the theory argues that an individual will automatically be affected by changes in their environment, but this may not always be the case (Carillo, 2010). Even though external influences, forces and occurrences in an individual's environment may have some effect on the individual, it is certain the extent to which these influences may impact the individual and whether this is always the case for all individuals (Harrison et al., 1997). Making a general claim that the individual's environment affects their disposition may therefore be short-sighted given that individuals respond to environmental stimuli differently, a fact that the theory failed to consider (Carillo, 2010).

Other scholars also claim that the theory lacks systemic structure as it is "loosely organised" and largely based on the interactions between a person, their behaviour and the environment (Lent et al., 2017). Critics of the theory have explained that this results in ambiguity regarding how these factors affect the individual and which one has a greater effect than the other. Similarly, some researchers claim that the

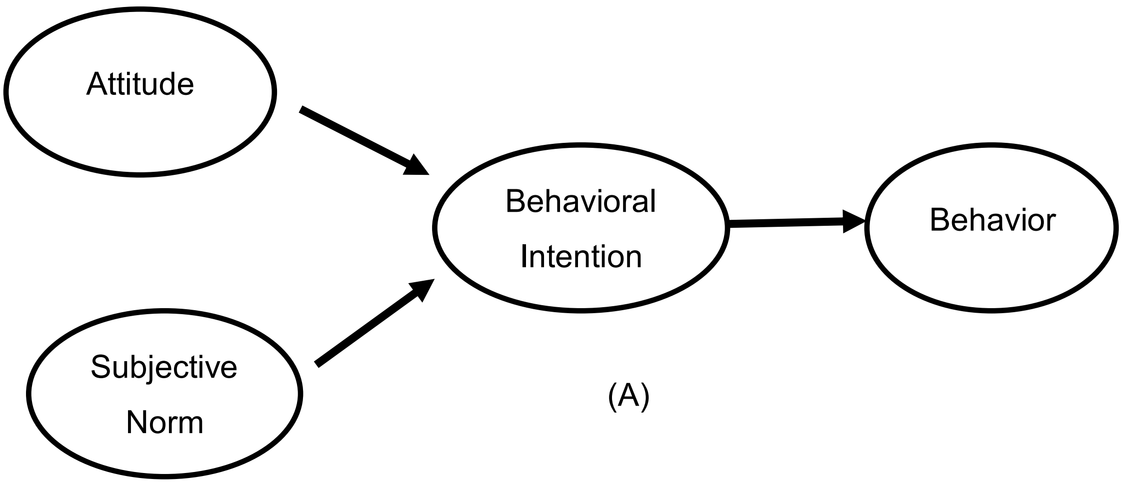
SCT fails to consider the impact of biological and hormonal factors on human behaviour (Armitage & Conner, 2000). Their arguments are based on the notion that biological and hormonal factors can often disrupt an individual's behaviour even if environmental forces remain the same (Sheu et al., 2010). Finally, some scholars also claim that the theory does not consider emotion and motivation and is also difficult to operationalise in its entirety (Schunk & DiBenedetto, 2020).

3.5.3 Theory of Reasoned Action (TRA)

The Theory of Reasoned Action (TRA) is a theory that has been used extensively over the years to explain the relationship between attitudes and behaviour (LaCaille, 2020; Xiao, 2020).

3.5.3.1 History of theory of reasoned action

The Theory of Reasoned Action was propounded by Fishbein and Ajzen (1967), who claimed that behavioural intentions precede actual behaviour. The theory of reasoned action came to the fore in 1967 through the work of Fishbein and Ajzen (1967), who sought to explain how attitudes and subjective norm influence behavioural intentions, resulting in actual behaviour. A key postulation of this theory was the fact that behavioural intentions did not constitute actual behaviour but could result in actual behaviour (Ajzen & Fishbein, 1980).



(A)

Figure 3. 2: Theory of Reasoned Action

Source: Ajzen & Madden (1986:454).

3.5.3.2 Assumptions and Components of theory of reasoned action

The core postulation of the Theory of Reasoned Action is that the formation of any behaviour is dependent on the intention to perform the behaviour, which is also dependent on the attitudes toward performing the behaviour and the individual's evaluation or perception of the outcomes of performing the behaviour (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975). The Theory of Reasoned Action helps to explain the importance of attitudes and subjective norms in establishing intentions to perform a behaviour. Fishbein and Ajzen (1975) found that an individual's attitude and subjective norms often influence the intention to perform or exhibit a particular behaviour. As such, if the attitude and subjective norm is negative or weak, it is likely to reduce the intention to behave in a particular way (Proctor et al., 2019).

Proponents of the theory further argue that the two determinants of Behavioural Intention (BI) are embedded belief sets associated with the formation of behaviour. Attitude is perceived as a function of salient beliefs, which seeks to examine the value of outcomes that result from a behaviour, whilst subjective norm also refers to the function of an individual's belief system, which determines whether a person's value system will be compromised if they engage in a particular behaviour (Copeland & Zhao, 2020). According to Fishbein and Ajzen (1975), there are two fundamentally different sets of beliefs influencing behavioural intentions, and these are classified as (i) behavioural and (ii) normative.

Researchers view behavioural beliefs as having the greatest influence on attitudes, whilst normative beliefs are directly related to the subjective norms of an individual (Karnowski et al., 2018). As a result, an individual's behavioural intentions can only be influenced by their attitude or subjective norms, which is one of the core assumptions underpinning the Theory of Reasoned Action (Ajzen & Kruglanski, 2019).

Fishbein and Ajzen (1975) further examined the impact of external influences on behaviour and found that external variables can only impact behavioural intentions through attitude or subjective norms. Consequently, in seeking to influence behavioural intentions, an individual's attitude and subjective norms represent the most feasible opportunity to achieve behaviour change. Researchers have concluded that the theory of reasoned action effectively explains individuals' volitional behaviour by exploring the relationship between an individual's attitudes, subjective norms and behavioural intentions (Hale et al., 2002). Regarding behaviour change theories, the TRA is regarded as very useful in explaining the impact of individual beliefs on their behavioural intentions (Chen, 2022). This is the key to unlocking desired behaviour, as a positive intention to act often translates into positive behaviour. As a result, when behavioural intentions are positive, the desired outcome will likely be positive (Jang & Cho, 2022).

3.5.3.4 Criticisms of the theory of reasoned action

Like previous theories, the TRA has also received its fair share of criticism. Some scholars believe the theory is useful in explaining an individual's voluntary behaviour but cannot explain spontaneous, impulsive and irrational behaviour (Langer, 1989). These critics argue that sometimes certain external factors can impact an individual's behaviour, which has not been accounted for in the theory of reasoned action (Ajibade, 2018).

3.5.4 Theory of Planned Behaviour (TPB)

The Theory of Planned Behaviour (TPB) is another popular theory that seeks to explain behaviour change amongst individuals. The TPB has, over the years, been extensively used to investigate the role of attitude, subjective norm and perceived behavioural control as predictors of behavioural intention (Ajzen, 2006; Ajzen, 2020).

3.5.4.1 History of the theory of planned behaviour

The Theory of Planned Behaviour (TPB) originated from the work of Ajzen (1991), who sought to explain how to predict human behaviour through three factors which influence behavioural intention, namely: attitude, subjective norm and perceived behavioural control. The Theory of Planned Behaviour was developed in response to the limitations of the Theory of Reasoned Action, and the inclusion of perceived behavioural control was deemed to be essential in explaining how attitudes and subjective norms could contribute to the formation of behavioural intentions, which result in the actual behaviour (Ajzen, 2020). Ajzen's (1991) theory of planned behaviour has been widely used to explain behaviour change in many disciplines, featuring prominently in consumer behaviour studies (D'Souza, 2022; Ying et al., 2022).

3.5.4.2 Assumptions and components of the theory

The Theory of Planned Behaviour advances the argument that attitude, subjective norms and perceived behavioural controls are antecedents of behavioural intentions, predicting actual behaviour (Ajzen, 1991; Ajzen, 2006; Azjen, 2020). The theory assumes that these three dimensions influence a person's intention to behave in a particular manner or exhibit a certain behaviour. Ajzen (2006) explains that the interaction of these three dimensions culminates in behavioural intention. For any desired behaviour to occur, the intention must first exist. The introduction of perceived behavioural control also helps to explain how an individual's behavioural intention can be influenced by the resources and support an individual has access to (Madden, Scholder Ellen & Ajzen, 1992). The TPB generally posits that if the intention to perform a behaviour is high, then the behaviour is likely to occur (Ajzen, 1991). This is aided by an individual's personal factors, which may include skills, resources and other benefits that can enable an individual to exert some influence on an outcome or situation.

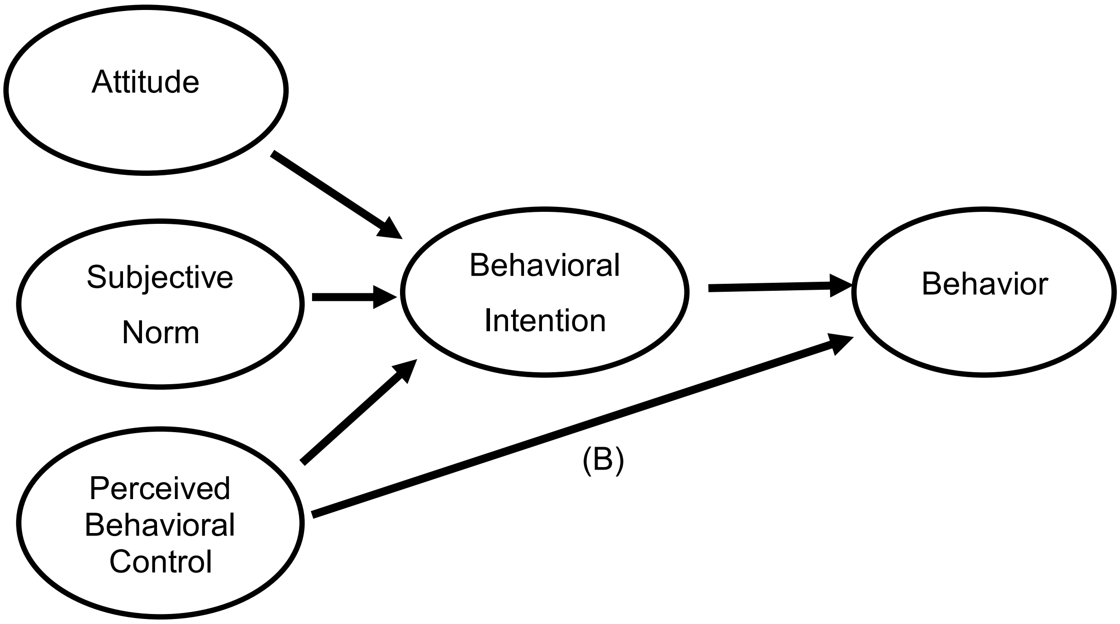


Figure 3. 3: Theory of Planned Behaviour
Source**:** Ajzen (1991: 182).

3.5.4.3 Criticisms of the theory

The TPB evolved from the TRA and shared some similarities with the former. Nonetheless, the difference between the two theories is the introduction of perceived behavioural controls, which Azjen (1991) introduced to improve the previous postulations of the TRA. However, some scholars have criticised the TPB, stating that in the absence of behavioural control, the TPB is virtually the same as the TRA (Miller, 2017). This criticism also stems from an observation that the components of the TPB are, according to Miller (2017), "incoherently operationalised", leaving gaps which could have been filled to avoid constant revisions of the theory. Furthermore, whilst the theory is useful in examining behaviour change when perceived behavioural control is introduced, there are still some arguments that a large percentage of variance in behaviour is unexplained by the TPB (Sniehotta et al., 2014).

3.5.5 Decomposed Theory of Planned Behaviour (DTPB)

This section expounds on the history of the DTPB together with its assumptions to help understand the theory.

3.5.5.1 History of DTPB

Taylor and Todd (1995) are credited with DTPB. This theory builds on the original Theory of Planned Behaviour (TPB) and explains how various beliefs influence behaviour intention. The Theory of Planned Behaviour was instrumental in highlighting how an individual's intentions to perform a certain behaviour were a result of three key factors, namely: the attitude towards the behaviour, the social influences and the perceived control affecting the intended behaviour (Ajzen, 2006; Ajzen, 2020). Taylor and Todd (1995), through the DTPB, add to the original theory by breaking these three influences into more detailed dimensions, which help to explain behavioural intentions and eventual behaviour.

3.5.5.2 Assumptions and components of the DTPB

A decomposed model provides several advantages over a unidimensional belief structure because it has been shown that belief has various dimensions and can be explained from different perspectives (Nyasulu & Dominic Chawinga, 2019). Taylor and Todd (1995) argue that decomposition offers the added benefit of flexibility which can be used to identify a set of beliefs which can be applied in various contexts. In the DTPB, the antecedents of intentions are identified as attitude, subjective norm and perceived behavioural control. Each of these are further decomposed (Garay, Font & Corrons, 2019). Behavioural beliefs are decomposed into trust, perceived usefulness, perceived ease of use and perceived enjoyment (Kanimozhi & Selvarani, 2019). Normative belief is decomposed into influence exerted by friends, batch-mates and family. Control belief is decomposed into self-efficacy (Garay et al., 2019). These new elements help to explain the impact of beliefs of behavioural intention and offer a broader view than the traditional TPB.

Dwidevi et al. (2009, p. 293) define DTPB as a "variation of the TPB which breaks down attitudinal, normative and control beliefs into a set of more measurable variables". The DPTB developed by Taylor and Todd (1995) explains behaviour intention to adopt new information technology based on two important approaches: (1) the intention-based research and (2) the transmission of an innovative approach. The intention-based research employs behaviour intention (BI) in predicting adoption behaviour by identifying factors such as attitude, social influences and facilitating conditions (Taylor & Todd, 1995). Taylor and Todd (1995) further refine the TPB by deconstructing the belief construct into several antecedents. Therefore, DTPB focuses on identifying various belief factors that predict behavioural intention, which provides a more complete understanding and identifies more relevant belief factors.

Khasawneh and Irshaidat (2017) claim that the postulations of the DTPB are premised on the Theory of Reasoned action (TRA), which seeks to explain voluntary individual behaviour based on attitude and subjective norms which contribute to behavioural intention. The DPTB, however, seeks to overcome the limitations of the TRA by including perceived behaviour control (PBC) in addition to attitude and subjective norm, which are both TRA components (Sadaf & Gezer, 2020). These additions were made to ensure that the theory accounts for the common situations where consumers often suffer from anxiety, hesitancy or apprehension in relation to innovation, a situation further compounded when consumers do not possess absolute voluntary control (Garay et al., 2019). Lin (2007, p.434) states that the DTPB decomposes the TPB into multidimensional belief constricts and "specifies that the attitudinal belief has three innovation characteristics that influence behavioural intentions: relative advantage, complexity, and computability." Lin (2007:435) further claims that "…previous studies generally took personal influence (normative influence) as a determinant of subjective norms. Whereas the decomposition of PBC consists of: self-efficacy (SE) and facilitating conditions (FC)."

The DPTB offers a more holistic construct that accounts for various belief factors, self-efficacy, and facilitating conditions that encourage individuals to develop the intention to behave in a desired manner.

3.5.6 Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) narrative is provided under this section as an introduction to the model's premises and components. The section expands on the model's detractors in more detail.

3.5.6.1 History of technology acceptance model (TAM)

The Technology Acceptance Model was propounded by Davis (1989). TAM has, over the years, been used by various researchers to explain the factors that influence an individual's decision to accept technological innovations (Lee, Hsieh, & Hsu, 2011). The Technology Acceptance Model (TAM) is a theory with its origins in two psychological theories, namely: The Theory of Reasoned Action (TRA) and the Theory of Planned Behaviour (TPB) (Legris et al., 2003; King & He, 2006; Venkatesh & Bala, 2008). TAM is now widely regarded as one of the important theories that can explain the adoption of technology and the factors influencing the consumer's decision to accept or reject a new technology (Holden & Karsh, 2010; Marangunić & Granić, 2015).

3.5.6.2 Assumptions and components of TAM

The main assumption of the Technology Acceptance Model is that two key factors influence an individual's decision to adopt and use an innovation or new technology; Perceived Ease of Use (PEOU) and Perceived Usefulness (Davis, 1989). Some scholars claim that TAM has to a large extent, simplified the theoretical landscape for technology adoption by highlighting the importance of PEOU and PU in influencing consumers to adopt new technologies. (Giovanis et al., 2012). PU has been defined as “the degree to which a person believes using a particular system would enhance his or her job performance” (Venkatesh, Morris, Davis & Davis, 2003:445). This component of TAM accounts for the willingness of an individual to accept a new system due to the perception that it is relevant to their functional needs. In the context of this thesis, for example, PU can help explain how smallholder farmers will be willing to adopt rice irrigation systems if they perceive that these systems can help them perform better.

PEOU is also defined as “the degree to which a person believes that using a particular system would be free of effort” (Venkatesh, Morris, Davis & Davis, 2003:451). Previous studies have confirmed that complexity results in resistance to adoption and change (Pathak et al., 2019). Consequently, TAM proposes that when an individual identifies technology as lacking complexity, the individual is likely to adopt that technology (Min et al., 2019). Kim (2016, p.2) defines attitude in the context of technology adoption as “a person forming favourable or unfavourable feelings toward adopting a certain technology”. Wang et al. (2012) confirm that PEOU and PU can influence individuals to have a positive attitude, resulting in a positive intention to use a particular technology. Figure 3.4 presents an illustration of the technology acceptance model and its components.

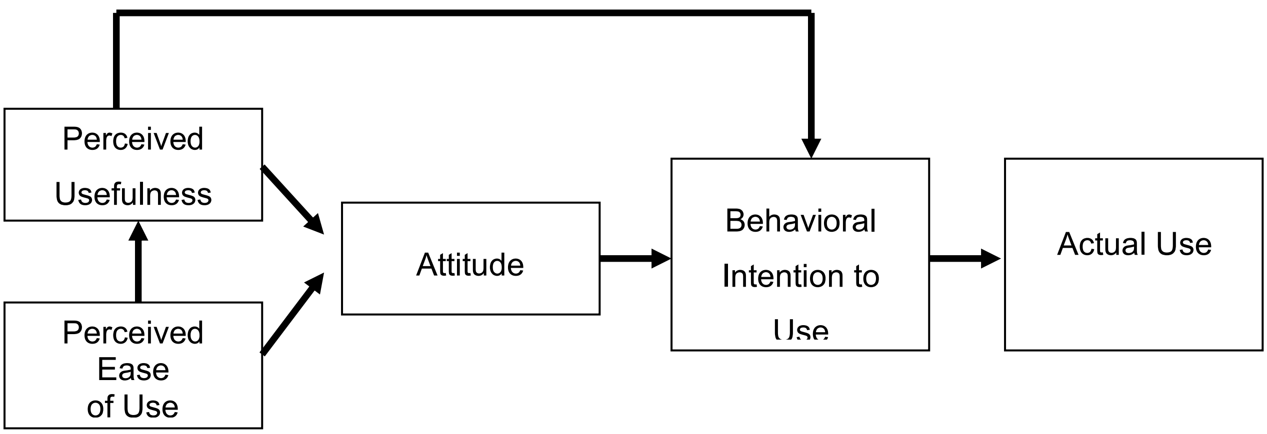


Figure 3. 4: Technology Acceptance Model

Source**:** Davis (1989:322).

From Figure 3.4, PU and PEOU are two exogenous constructs, whilst attitude and intention to use are the endogenous factors in the model. The model essentially posits that perceived usefulness and perceived ease of use are two predictors of attitude, which in turn predicts behavioural intention and results in the final adoption or acceptance of the technology. A recent study by Djimesah et al. (2022) confirms that PEOU and PU are vital components needed to facilitate technological adoption.

3.5.6.3 Criticisms of the technology acceptance model

A review of the extant literature in relation to adoption theories reveals that even though several researchers have used TAM, the theory has been criticised for its shortcomings, especially in relation to its limited theorisation of factors influencing the adoption of technology (Ajibade, 2018). For instance, King and He (2006) criticised the TAM model as simplistic and with limited practical application. Ajibade (2018, p.4) also weighs in with a limitation of TAM and claims that "One of the limitations of the TAM concerns the variable which pertains to the behaviour of users, which is inevitably evaluated through subjective means such as behavioural intention (BI) such as interpersonal influence."

According to Ajibade (2018), interpersonal influence as a subjective norm affecting behavioural intention does not apply in all instances, especially in work settings, where a superior in an organisation or a shift in organisational policy requires an individual to adopt a technology. In such a scenario, the individual was not compelled by friends or family but by organisational factors. This leads to the criticism of the claim that social pressure through family or friends could influence an individual's decision to adopt a technology. However, this is not always the case, and that highlights one of the limitations of TAM.

3.5.7 Revised Technology Acceptance Model (TAM2)

Researchers frequently use the Revised Technology Acceptance Model, much like they did with the original Technology Acceptance Model, to explain and predict why users may occasionally accept and occasionally reject innovations (Venkatesh and Davis, 2000). The theory's narratives and assumptions are presented in this section.

3.5.7.1 History of TAM 2

Since the emergence of the Technology Acceptance Model (TAM), various scholars have made many contributions towards its revisions and have sought to adapt the theory to their specific contexts and research parameters (Sheng & Zolfagharian, 2014). The revision to the original TAM model was proposed by Venkatesh and Davis (2000), who identified the possible role that perceived usefulness could play in influencing an individual's decision to adopt, reject or continue using an innovation. Venkatesh and Davis (2000) took cognisance of the fact that many empirical studies that had operationalised the first version of the technology acceptance model examined perceived usefulness from the perspective of usage intentions. They sought to extend the theory by demonstrating that perceived usefulness and usage intentions can change over time. TAM 2 was established based on the premise that two variables, namely social influence and cognitive instrumental processes, significantly affected user acceptance (Venkatesh & Davis, 2000).

3.5.7.2 Assumptions and components of TAM 2

Many researchers suggested that additional variables must be included in the TAM to give the model an even stronger predictive ability (Legris et al., 2003). The TAM2 is an update of the TAM proposed by Venkatesh and Davis (2000) and seeks to add further clarity to the examination of factors that influence an individual's decision to accept or reject a technology. Venkatesh and Davis (2000) proposed in their revision of the initial TAM model that an extended model (TAM2) needed to exclude the attitude component whilst making provision for a new variable, namely subjective norm, which could help to explain the possible role of social influence, particularly from the perspective of colleagues at the workplace or employers or superiors who have control or influence over an individual. Thus, even though the attitude component in TAM 1 originally mediated part of the relationship between perceived usefulness and perceived ease of use, it was excluded from TAM2 due to the shift in focus and the amplified role of the subjective norm, which was used to capture social influence.

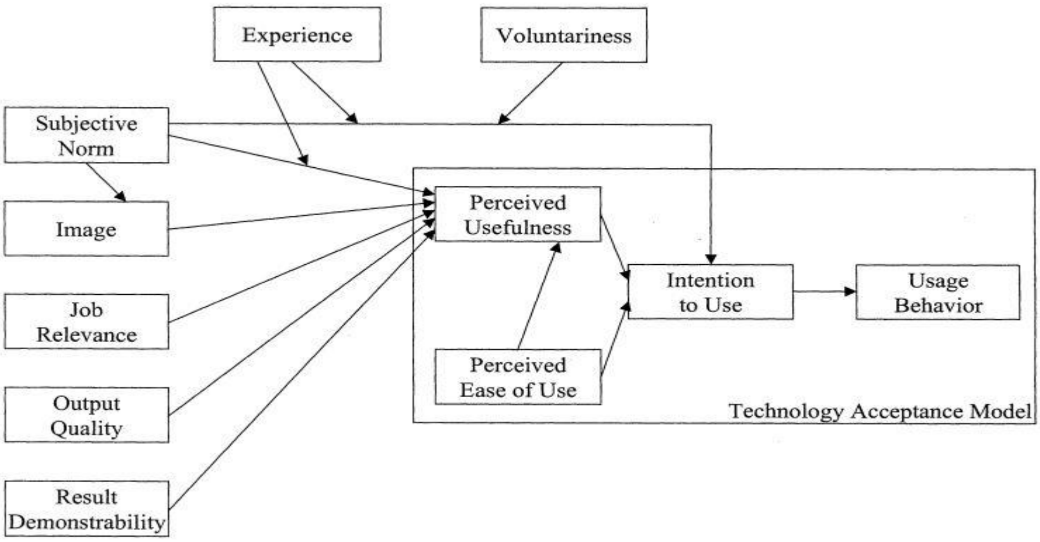


Figure 3. 5: Revised Technology Acceptance Model (TAM2)

Source**:** Venkatesh and Davis (2000:188).

In TAM2, Venkatesh and Davis (2000) argued that the variable subjective norm has a direct effect on an individual's intention to perform a behaviour. This effect is not based on how individual's emotions but more on what others perceive that the individual should do. As a result, Venkatesh and Davis (2000) postulate that an individual is moved towards technology acceptance based on the pressure from members in their social settings, especially at work. When an individual is mandated to adopt a technology, subjective norms directly influence intention over perceived usefulness and perceived ease of use. Venkatesh and Davis (2000) also highlighted the role of voluntariness as a moderating variable which explains the disposition of the individual towards technology acceptance, either a mandatory or voluntary acceptance.

From Figure 3.5, it can be perceived that subjective norms can influence intention indirectly through perceived usefulness, and that effect is termed internalisation (Venkatesh & Davis, 2000; Hoong et al., 2017). TAM2 posits that in mandatory system settings, the direct effect of subjective norms on usage intentions will take precedence over perceived usefulness and ease of use (Venkatesh & Davis, 2000). This is made possible through the role of variables such as job relevancy, output quality, and result demonstrability, which all impact perceived usefulness. Essentially, TAM 2 seeks to explain the behaviour of individuals to accept a technology based on social influence processes which are manifested in the variables subjective norm, voluntariness, and image, and also through cognitive instrumental processes of which job relevance, output quality, result demonstrability, and perceived ease of use are conceptualised as significantly influencing user acceptance.

3.5.8 Augmented Technology Acceptance Model (A-TAM)

The Augmented Technology Acceptance model is another theoretical position that is discussed in the context of this thesis on ATA.

3.5.8.1 Overview of A-TAM

As discussed earlier, Davis (1989) propounded the technology acceptance model based on the realisation that two constructs, Perceived Usefulness (PU) and Perceived Ease of Use (PEOU), were vital in explaining an individual's decision and intention to adopt new technology. After the proliferation of TAM 1, various modifications of the theory have emerged, such as TAM2, discussed previously, and the Augmented Technology Acceptance Model. Even though scholars have claimed that TAM 1 is a parsimonious model which can be applied in multiple studies and contexts, other scholars have asserted that the original model can be modified based on the context in which a study is being conducted (Venkatesh & Davis, 2000; Al-Emran et al., 2018). From the limited literature available, the augmented technology acceptance model (A-TAM) is an extension of the technology acceptance model, which has been used to explain the factors underpinning user's intention to adopt augmented reality and virtual reality technology (Rese et al.,2014; Papakostas et al., 2022).

This revised version of TAM argues that user acceptance of new technologies is an antecedent to the successful diffusion of technological innovation (Aldhaban, 2012). In relation to this, scholars have found that new technologies such as Augmented Reality (AR) could be predicted by variables that include enjoyment (Haugstvedt & Krogstie, 2012; Shin, 2007), personal innovativeness (Zarmpou et al., 2012), perceived benefits (Olsson et al., 2012), as well as information quality (Jung et al., 2015; Olsson et al., 2012). Other scholars such as Kim, Chan, and Guota (2007) also claim that in the domain of technology acceptance research, monetary and non-monetary costs have been identified as factors influencing user acceptance of new technology. Tom Dieck and Jung (2018) tested that in their study and found that for some individuals, the monetary cost of the technology influences their adoption decision, whilst, for others, the cost comfort and the fear of missing out on information are examples of non-monetary costs that also influence the acceptance of new technology.

In other studies, personal innovativeness has been identified as a personal factor influencing an individual's decision to adopt new technology, such as augmented reality (Lee et al., 2006; Choi et al., 2011; Gao et al., 2012). Furthermore, a review of the extant literature reveals that several researchers investigating technology acceptance have found that personal innovativeness has emerged as one of the factors influencing some individuals to accept and use new technology (Choi et al., 2011). For example, Lee et al. (2006) factored personal innovativeness into their TAM-based model and theorised that it positively and significantly affects perceived ease of use and usefulness. These views suggest that factors such as personal innovativeness, perceived enjoyment, and monetary and non-monetary costs need to be factored in for consumers seeking to adopt novel technologies such as augmented reality.

3.5.9 Unified Theory of Acceptance and Use of Technology (UTAUT)

Lastly, a thorough framework called the Unified Theory of Acceptance and Use of Technology (UTAUT) was created by Venkatesh et al. (2003) to comprehend and explain the variables influencing the acceptance and usage of technology in many contexts. UTAUT has garnered a lot of attention in the literature and has been shown by numerous studies to be a valid model for explaining and predicting users' acceptance behavior regarding the use of new technologies in many areas (Almaiah, Alamri, & Al-Rahmi, 2019; Abdullah, & Ward, 2016; Ozkan, & Kanat, 2011; Abubakar, & Ahmad, 2013). Researchers make extensive use of this theory. This section presents the background and underlying assumptions.

3.5.9.1 History of UTAUT

UTAUT, which was first presented by Venkatesh et al. in 2003, synthesizes and expands on previous ideas by assembling important factors that influence people's choices on whether to adopt and use new technologies in their daily lives. Four fundamental elements are considered in this theoretical framework: social influence, performance expectancy, effort expectancy, and facilitating conditions. Performance expectations pertain to the anticipated advantages and practicality of a technology, whereas effort expectancies are associated with the perceived simplicity of operation. According to Venkatesh et al. (2003), enabling conditions evaluate the perceived support and resources available for technology use, while social influence takes into account the impact of interpersonal and societal elements. UTAUT is a flexible and popular model for researching technology adoption across various domains and user groups since it has developed and changed over time to include new elements and contextual changes (Al-Saedi, Al-Emran, Ramayah & Abusham, 2020). UTAUT is a useful resource for scholars, practitioners, and policymakers that aim to improve the effective adoption and assimilation of novel technologies, as it offers a thorough comprehension of the factors that impact technology acceptance.

3.5.9.2 Assumptions and components of UTAUT

The fundamental tenet of UTAUT is that people's decisions to adopt and use technology are heavily influenced by four key elements. According to Venkatesh et al. (2003), these constructs are performance expectancy, effort expectancy, social influence, and facilitating conditions. These elements are seen to be crucial in influencing users' attitudes and actions toward the adoption of technology. Performance expectations are a major factor in determining whether or not people choose to use a specific technology. It continues to be the most reliable indicator of intention when accounted for by experience, gender, and age (Venkatesh et al., 2003; Attuquayefio & Addo, 2014). Performance expectancy is essentially a measure of how much people believe that a particular technology will improve their productivity, overall effectiveness, or job performance. Perceived utility is one component of performance expectancy (Venkatesh et al., 2003; Davis, 1989). According to the theory of perceived utility, people evaluate a technology's perceived value or utility based on how well it allows them to complete tasks. The degree to which the technology meets the demands and goals of users, as well as its features, functions, and capabilities, all have an impact on perception. The relative benefit of the technology is another factor that influences performance expectations (Venkatesh et al., 2003). Users assess the new technology's apparent benefit over current alternatives. When users compare the new technology's benefits to those of what they already have, performance expectancy is increased if the new technology is thought to offer significant advantages.

The effort expectancy construct is the second one. Essentially, effort expectancy is a reflection of how easy and convenient a user feels they can interact with a particular technology (Venkatesh et al., 2003). The perceived ease of use of the technology is one factor that influences effort expectancy. Technology improves effort expectation if it is viewed as intuitive, user-friendly, and simple to use. The technology's general design, navigation, and user interface, among other things, may have an impact on this perspective (Attuquayefio & Addo, 2014; Venkatesh et al., 2003; Davis, 1989). Stated differently, users assess the level of intricacy inherent in the technology and the mental strain necessary for interaction. In terms of effort expectancy, technologies that are simple to use and demand little mental work are more likely to get favourable reviews.

Social influence is the third construct in the UTAUT primary premise (Venkatesh et al., 2003). The term "social influence" describes how other people's thoughts, attitudes, and actions affect a person's decision to accept technology. According to several studies (Attuquayefio & Addo, 2014; Venkatesh et al., 2003; Davis, 1989), subjective norms are recognized as elements of social influence. Subjective norms are integrated with the perceived societal pressures and expectations surrounding the adoption of a specific technology (Al-Saedi, et al., 2020). When creating their own attitudes and intentions, people take important individuals' opinions—friends, family, coworkers, and supervisors—into consideration. Adoption of a particular technology by a peer within a social group can have a beneficial effect on others, since they may believe that adopting the technology is in line with group norms and expectations.

Last but not least, facilitating conditions, which touch on people's perceptions of the organizational and technical infrastructure support that is available to help them use the technology effectively (Venkatesh et al., 2003). The importance of creating a welcoming atmosphere for users to adopt and use technology is highlighted by facilitating conditions. By making the required infrastructure investments, providing thorough training programs, guaranteeing compatibility with current systems, and cultivating an organizational culture that promotes and supports technology adoption, organizations and technology developers can improve the facilitating conditions. Stakeholders can remove barriers and establish an atmosphere that is favourable for the successful adoption and integration of technology by addressing facilitating factors.

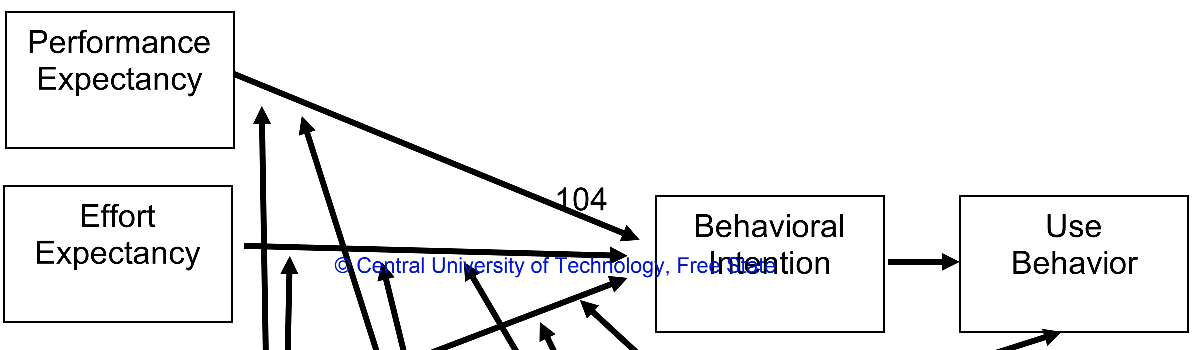


Figure 3. 6: Unified Theory of Acceptance and Use of Technology (UTAUT)

Source: Venkatesh, Morris, Davis and Davis (2003: 447)

3.6 THEORETICAL FRAMEWORK ADOPTED IN THE STUDY

Based on the review of adoption theories, three theories have been selected as the underpinning theories anchoring this study on the adoption of agricultural technology by smallholder farmers in Ghana. These theories and their application in this study are discussed in this section.

3.6.1 Technology Acceptance Model (TAM)

The technology acceptance model is adopted as one of the theoretical positions of this study. The choice of this theory is anchored on the fact that the core assumptions of the technology acceptance model help in explaining the process of agricultural technology amongst smallholder farmers. According to the arguments put forward by the proponents of TAM, an individual's willingness to adopt a technology is influenced by two key factors, which are the ease with which the individual can use the technology, and the perceived usefulness of the technology and how it fits into the life of the individual (Kamal et al., 2020). Therefore, in this study, the propositions of the technology acceptance model are used in explaining two key factors that determine smallholder farmers’ willingness to adopt rice irrigation systems; perceived ease of use and perceived usefulness.

TAM argues that once a technology is viewed as relevant, it will likely be adopted. In that case, the same argument can be put forward in relation to rice irrigation technology. If the technology is simple and easy to use, and if smallholder farmers are equipped with the relevant skills, then adopting the agricultural technology becomes easier. This study theorises that the intention of smallholder farmers to adopt rice irrigation systems will be higher if the two conditions of perceived usefulness and perceived ease of use are met. However, this is also influenced by cultural factors and consumer behaviour factors, which can determine whether or not smallholder commercial rice farmers in the Volta Region of Ghana intend to adopt agricultural technology. In this study, the technology acceptance model helps to explain the relationship between perceived usefulness of a technology and farmers' willingness to adopt agricultural technology. Similarly, the relationship between perceived ease of use of a technology and farmers' willingness to adopt agricultural technology is explained by TAM.

Some researchers claim that the willingness to adopt an innovation depends on other factors aside from the characteristics of innovations as conceptualised by Rogers (1995). Aside from relative advantage, complexity, compatibility, social influence and observability, other key considerations influence individuals' intention to adopt new technology. In the case of this study, PEOU and PU are critical for stimulating the interest of smallholder farmers towards the intention to adopt rice irrigation technology to improve their output and yield. In this study, TAM is one of the theories used to explain the impact of perceived ease of use and perceived usefulness on the willingness of farmers to adopt agricultural innovations.

3.6.2 Decomposed Theory of Planned Behaviour (DTPB)

The second theoretical position this thesis seeks to leverage is the Decomposed Theory of Planned Behaviour (DTPB). This theory builds on the Theory of Reasoned Action (TRA) and introduces new components that help explain and predict behaviour better than the TRA. In the context of this study, the DTPB will help explain the decomposition of subjective norms in the conceptual framework into peer and superior influences. This will help to explain the role of these two variables in facilitating the adoption of agricultural technology by smallholder farmers in Ghana. Subjective norms refer to an individual's belief about whether or not most people in their social circle want them to engage in a particular behaviour (Ulker-Demirel & Ciftci, 2020). The literature has confirmed that in relation to the adoption of technology, social influence plays a crucial role (Ajzen, 2020). Consequently, this study leans on the DTPB to highlight the role of superior and peer influence in ensuring that smallholder farmers adopt agricultural technology. In this study, peer influence comprises of colleague smallholder farmers and friends, whilst superior influence could be conceptualised as agricultural extension officers and their work in educating farmers on various innovations and new technology.

In this study, the DTPB was used to incorporate superior influence and peer influence into the conceptual framework to measure the impact of social consumer behaviour factors in influencing the adoption of agricultural technology. The application of this theory has resulted in a multidimensional construct examining the behavioural dimensions of adoption, which have been hypothesised to influence the adoption of agricultural technology. Nor and Pearson (2005) view interpersonal influences as significant factors determining whether individuals adopt or reject a technology. Ramirez (2013) further stated that social networks exert pressure on farmers' adoption decisions in relation to technology adoption. The decision to adopt the DTPB will help highlight how multidimensional behavioural factors impact ATA.

3.6.3 Diffusion of Innovation Theory (DoIT)

The Diffusion of Innovation Theory (DoIT) explains the process of influencing smallholder farmers to adopt agricultural technology to improve yields and harvest. The DoIT has been discussed in the earlier part of this chapter and argues that before consumers adopt an innovation, a process of diffusion has to take place (Rogers et al., 2014; Dibra, 2015). In the context of this study, the adoption of agricultural technology, specifically irrigation technology for rice farming by smallholder farmers, depends to a large extent on how successful innovation operators can diffuse it. The DoIT is used in this study to explain the need for agricultural technology to be diffused in relation to its perceived benefits and relative advantage over other methods that smallholder farmers may use. The DoIT argues that for an innovation to be successful, five characteristics need to be present, and these are: relative advantage, compatibility, complexity, observability and social influence (Rogers, 2003).

This study applies the DoIT to explain how smallholder farmers can be engaged to facilitate ATA. The postulations of the DoIT theory suggest that when smallholder farmers perceive innovations such as irrigation to be better than previous techniques, they are likely to adopt and engage in irrigation practices. This is predicated on certain contextual factors such as social influence and self-efficacy. Social influence comes to the fore when smallholder farmers witness the success of adopting agricultural innovations by colleagues, family or friends. Social influence plays a huge role in facilitating the adoption of innovations and is likely to have a ripple effect in the agricultural sector. As such, the theory highlights the role of observability in stimulating adoption intentions. If smallholder farmers observe and see other farmers successfully implementing innovations and reaping the rewards in terms of bumper harvests, improved productivity and yield, they are likely to follow suit. The DoIT also stresses that innovations need to be perceived as less complex and easy to use. Agricultural technology, such as rice irrigation, can be portrayed in this light through training programmes to ensure that smallholder farmers understand the technicalities required to implement rice irrigation systems successfully. Training smallholder farmers can result in self-efficacy, which can contribute to the successful adoption of the technology. It can also help to combat resistance to change and other psychological barriers which may hinder the adoption of the technology. The DoIT's role in this thesis is to help explain the relationship between self-efficacy and farmers' willingness to adopt agricultural technology and the relationship between the complexity of a technology and farmers' willingness to adopt agricultural technology. The postulations of the DoIT also help in the development of a conceptual framework which proposes some consumer behaviour technology adoption strategies.

3.7 CHAPTER SUMMARY

This chapter was dedicated to a review of the major theories influencing the adoption of technologies. The chapter commenced by providing a background on consumer purchase decisions, factors influencing consumer purchase decisions and consumer behaviour strategies. This sets the tone for discussing eight (8) theories influencing consumer adoption of technologies. The theories discussed include the Diffusion of Innovation Theory (DoIT), Social Cognitive Theory (SCT), Theory of Reasoned Action (TRA), Theory of Planned Behaviour (TPB), Decomposed Theory of Planned Behaviour, Technology Acceptance Model (TAM), Revised Technology Acceptance Model (TAM 2), and Augmented Technology Acceptance Model (A-TAM).

The review of the various adoption theories resulted in choosing three (3) theories to underpin this study: DoIT, TAM and Decomposed Theory of Planned Behaviour. In addition, the research setting was discussed, which offered contextual insight into the specific agricultural programme being investigated in this study. Overall, this chapter has provided a discussion on the theoretical framework, which has highlighted the various theories that are influencing this study, and that will serve as the basis for further discussion in the examination and exposition of the conceptual framework to be presented in the next chapter. The following chapter presents the conceptual framework of the study to offer an understanding into the hypothesis in the study.

CHAPTER FOUR

AGRICULTURAL TECHNOLOGY ADOPTION CONCEPTUAL FRAMEWORK AND HYPOTHESES

4.1 INTRODUCTION

The previous chapter examined the theoretical framework for discussing the various theories underpinning this research. Specifically, three theories were adopted to explain the phenomenon of ATA in Ghana; the Technology Acceptance Model (TAM), Diffusion of Innovation theory (DoIT) and Decomposed Theory of Planned Behaviour (DTPB). In this chapter, the conceptual framework of the study is presented. This framework offers insight into the hypothesised relationships in this study, which reflects the research objectives and the theoretical framework.

The chapter begins with a discussion of the elements of consumer behaviour before examining the adoption behavioural dimensions. Next, the various hypothesised paths are reviewed in relation to established concepts in the literature and previous empirical studies. Overall, this chapter serves the purpose of displaying the conceptual framework of this study and delineating the various causal relationships hypothesised. Finally, the various pathways from the independent to the dependent variable are discussed, and support from existing studies is included to augment the various postulations made.

4.2 ELEMENTS OF CONSUMER BEHAVIOUR

The framework of this study includes elements of consumer behaviour which have been theorised to influence the adoption of agricultural technology in Ghana. Specifically, three factors will be examined: psychological, social, and personal. These three factors play a key role in determining whether or not consumers will adopt new technology. This study posits that these factors are equally key in examining smallholder farmers' attitudes towards agricultural innovation in Ghana.

4.2.1 Psychological factors

In this study’s conceptual framework, psychological factors play a key role in facilitating ATA. Psychological factors refer to the set of factors that influence the attitude and behaviour of consumers (Roberts, Flin, Millar, & Corradi, 2021; Gerli et al., 2022). In this study, two (2) psychological factors are operationalised as adoption behavioural elements that predict the adoption of agricultural technology by smallholder farmers in Ghana. These two factors are Perceived Usefulness (PU) and Perceived Ease of Use (PEOU). They are factors which are based on an individual’s assessment of technology in relation to its benefits and degree of complexity or simplicity (Flett, Alpass, Humphries, Massey, Morriss & Long, 2004; McDonald, Heanue, Pierce & Horan, 2016; Verma & Sinha, 2018).

Scholars have found that the degree to which an individual finds an innovation relevant to their needs impacts adoption behaviour (Bagheri, Bondori, Allahyari, & Surujlal, 2021; Ulhaq, Pham, Le, Pham & Le, 2022). Hence, PU is conceptualised in this study as an element of adoption behavioural dimension that positively affects ATA. Similarly, PEOU plays the role of an element of adoption behavioural dimensions which predicts the adoption of agricultural technology by smallholder farmers. These two psychological factors influence the decision-making of smallholder farmers in adopting technology for their farming activities (Kamrath, Rajendran, Nenguwo, Afari–Sefa & Bröring, 2018; Khoza et al., 2021). Furthermore, psychological factors impact the attitude and intention to use a technology, and in this study, PU and PEOU are conceptualised as determinants of ATA by smallholder farmers. These two factors will be expounded on in more detail in the subsequent sections, which will also discuss the causal effect of the predictors on the dependent variable.

4.2.2 Social factors

The second classification of the elements of consumer behaviour predicting adoption behavioural elements are social factors. In this study, social factors comprise of peer influence and superior influence. These two factors are hypothesised to influence the adoption of agricultural technology by smallholder farmers in Ghana. Peer Influence (PI) refers to the effect of colleagues and friends on the individual's decision to adopt a technology (McDonald et al., 2016; Wong et al., 2021; Ulhaq et al., 2022). In this study, peer influence refers to the opinions, advice and recommendations of fellow smallholder commercial farmers, which can influence the adoption of agricultural technology. Studies have found that peer influence is a significant social factor which can predict an individual's intention to adopt new technology. In the agricultural sector, peer influence has been tested in various studies amongst smallholder farmers. The results confirm that PI is a strong predictor of technology adoption in the agricultural sector (Abdullah et al., 2016; Cole & Fernando, 2021).

Superior Influence (SI) is also a social factor obtained from the deconstruction of subjective norms (Rhodes et al., 2002; Chang et al., 2013; Husin et al., 2016). SI refers to the influence that opinion leaders, elderly colleagues and high-ranking individuals at places of work have on an individual's intention to adopt technology (Sambodo & Nuthall, 2010; Maertens & Barrett, 2013; Ramirez, 2013). In the context of smallholder farming, SI refers to the thoughts, recommendations and actions of senior farmers, opinion leaders such as chiefs, and agricultural extension officers (Ward & Pede, 2015; Wang et al., 2020).

In this study, SI is also operationalised as a social factor that results in the formation of attitudes toward the adoption of agricultural technology. Further discussions in this chapter will examine the predictive role of superior influence on smallholder farmers' ATA. Both PI and SI are conceptualised and operationalised as predictors of technology adoption in the agricultural sector. They represent two of the adoption behavioural elements that are classified as social factors.

4.2.3 Personal factors

Another category of consumer behaviour elements that will be tested in this study is personal factors. Personal factors are individual-related factors that influence the adoption of technology (Rezaei, Safa, & Ganjkhanloo, 2020). In this study, personal factors include attitude, self-efficacy and complexity. Attitude is perceived to be one of the strong predictors of technology adoption behaviour (Lynne et al., 1995; Verma & Sinha, 2018). Previous studies have delineated the role of attitude in shaping behavioural intentions towards technology adoption (Adnan et al., 2019). Ajzen and Fishbein (1977) conceptualised and tested the link between attitude and behaviour and established the positive link between attitude and behavioural intentions. In this study, attitude is operationalised as a personal factor that predicts ATA.

According to De Vries et al. (1988), self-efficacy is the third element besides attitude and subjective norms that influence behavioural intentions. In this study, self-efficacy is adopted as one of adoption behavioural dimensions which influences technology adoption amongst smallholder farmers in Ghana. Self-efficacy refers to an individual's evaluation and assessment of their competency to use a technology to achieve their goals (McGinty, Swisher, & Alavalapati, 2008;

Sharifzadeh et al., 2017). This variable has been found to strongly predict the adoption of technology and, in this study, will be operationalised as a personal factor contributing to the adoption of agricultural technology.

Finally, complexity has also been chosen as one of the personal factors operationalised as an adoption behavioural dimension influencing ATA amongst smallholder farmers in Ghana. Several scholars have found that the degree of complexity of an innovation is directly related to the usage intentions and adoption of technology. This claim will be tested in this study as complexity will be operationalised as one of the predictors of ATA.

4.3 CONCEPTUAL FRAMEWORK AND HYPOTHESISED RELATIONSHIPS

The conceptual framework in Figure 4.1 below is developed based on the theoretical framework of the customer behaviour strategy presented in Chapter One. The adoption strategic perspectives over time will be tested against the psychological, social and personal variables and their effect on farmers' adoption behaviour. This follows Adnan, Nordin and Bakar (2017), who adapted the Technology Acceptance Model (TAM) to test how the constructs of the model influence the intention of agronomists towards adoption of Sustainable Agricultural Practice (SAP).

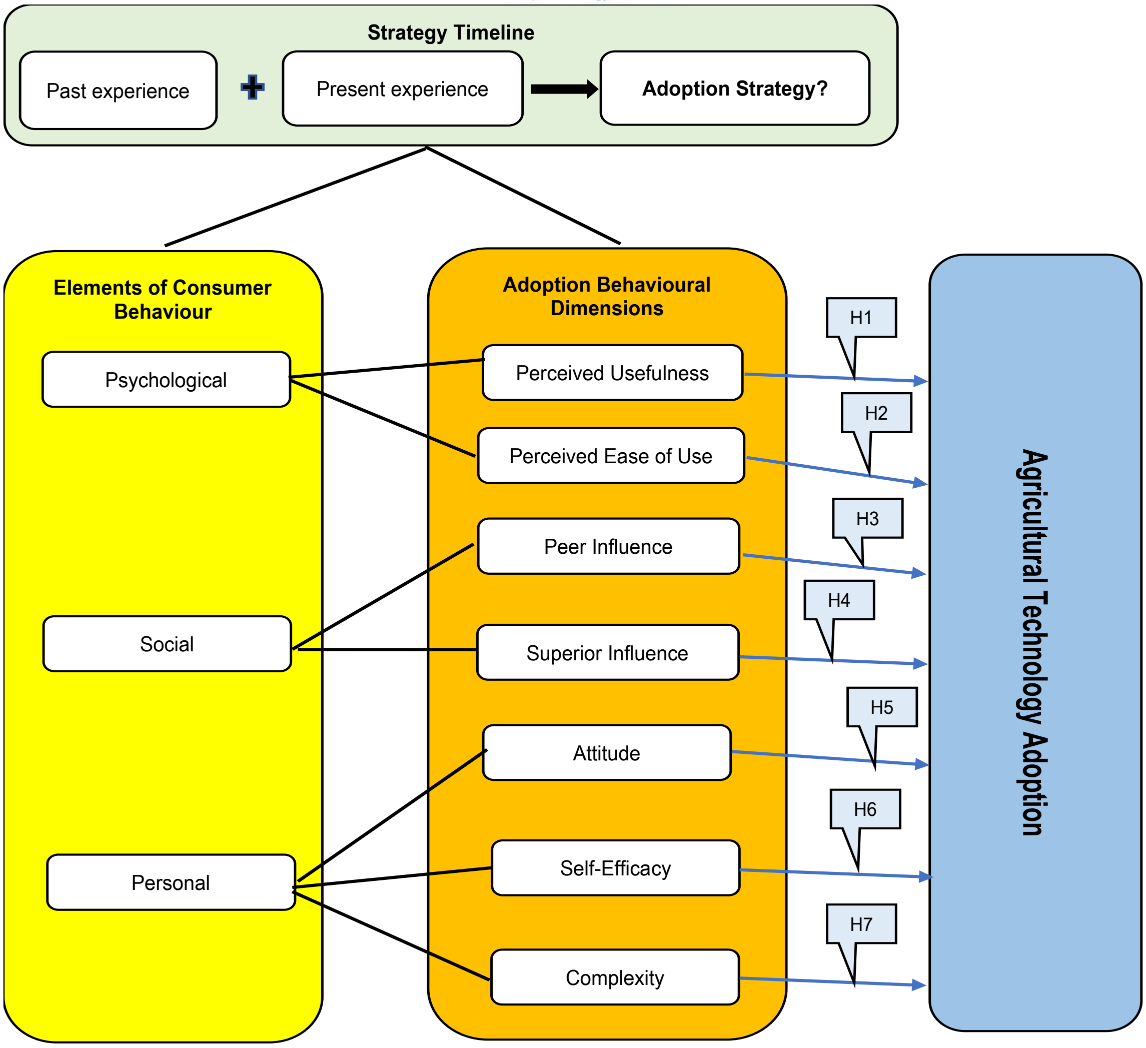


Figure 4. 1: Conceptual Framework

Notes: PU: Perceived Usefulness, PEOU: Perceived Ease of Use, PI: Peer Influence, SI: Superior Influence, AT: Attitude, SE: Self-Efficacy and COMP: Complexity.

The conceptual framework presented in Figure 4.1 illustrates the major postulations of this study, which is that psychological, social and personal factors are responsible for smallholder farmer adoption of agricultural technology. The framework is anchored on some assumptions. First, the dimensions of adoption behaviour are conceptualised as the independent variable in this study and comprise seven (7) variables categorised under three consumer behaviour elements (Psychological, Social and Personal). These seven (7) variables are hypothesised to positively and significantly affect smallholder farmers' adoption of agricultural technology. The framework's four main parts have causal influences and relationships: the strategy timeline, which explains how past and previous experiences influence the adoption of technology; the elements of consumer behaviour, adoption behavioural dimensions and ATA, which is the dependent variable.

4.3.1 Strategy timeline

The literature on technology adoption points to the fact that adopting new technology depends on a strategic timeline comprising the consumer’s past experiences and present experiences (Scott, Hughes, Hodgkinson, & Kraus, 2019; Belk et al., 2021). It is worth noting that an individual's past experience regarding the use of new technology can present challenges or opportunities for future technology adoption (Au & Enderwick, 2000; Son & Han, 2011). For example, if the past experience left the consumer with an unsatisfactory experience, then future adoption of technology is likely to be difficult. However, if the past experience using new technology was positive, then technology adoption is likely to be easier due to the historical precedent from the positive technology user experience (Saaksjarvi, 2003; Lee et al., 2022). Several scholars have established a link between past experience and future adoption of technology. These scholars highlighted the degree of complexity or ease of use of new technology and consumer adoption (Huang, Chang, Yu, & Chen, 2019; De Bellis & Johar, 2020). Significantly, if a technology posed challenges to an individual or group of consumers in the past, it is unlikely that they would be willing to consider using similar future technology (Zolfaghari, Thomas-Francois, & Somogyi, 2022).

The consumer behaviour literature acknowledges the phenomenon of consumer learning, which is applicable in the context of technology adoption (Tamilmani et al., 2018; Chavas & Nauges, 2020). When consumers adopt new technology, their experiences with the technology have the potential to influence future behavioural intentions (van Dijk et al., 2022). Consequently, the diffusion of technology has to factor in the learning behaviour of consumers and how flexible the technology developed can be assimilated and used by consumers (Mehta, Morris, Swinnerton & Homer, 2019). Negative adoption processes can scar consumers psychologically and emotionally, which can be a detriment to future technology adoption (Marikyan, Papagiannidis & Alamanos, 2020; Neves & Mead, 2021). Consumer learning implies that the process of cognitive reinforcement can occur for adopting technology. Therefore, if an adoption experience does not meet the consumer's expectations, they may be unwilling to repeat such an experience.

Therefore, the strategy timeline for adopting new technology considers a user's past experience because it is essential to understand which adoption strategy will be effective in getting the consumer to acquire and adopt the technology. Moving on from past experience, present experience with technology usage can also inform future adoption intentions and the adoption strategy used by either the consumer or the diffuser of the technology (Saurabh & Dey, 2021). Based on the strategy timeline, the present experience of technology usage refers to any current usage of technology and the user's experience in terms of benefits, challenges and adaptation (Roberts et al., 2021; Khan, Khan, Azhar, Shah, Uddin & Khan, 2021). For example, suppose technology helps users achieve their work or social goals. In that case, it registers a positive association in the consumer's memory which facilitates an intention to continue using the technology and similar technology in the future (Mohammed, White, G., Wang & Kai Chan, 2018). Adoption strategies must therefore factor in the consumer's past and present experiences to avoid creating technologies with low adoption rates.

From the conceptual framework in Figure 4.1, the strategy timeline affects the elements of consumer behaviour and the adoption behavioural dimensions. The past and present experiences with technology can inform a consumer's psychological, social and personal disposition (Tavitiyaman, Zhang & Tsang, 2022). Technology usage can affect an individual's psychological disposition because it can result in positive reinforcement (Wang, 2020). Positive reinforcement can result from successful outcomes from previous or present technology usage (Adnan et al., 2019). Adams and Jumpah (2021) aver that smallholder farmers can adopt new technology if it enhances their everyday experience and output.

The adoption of new technology must therefore be positioned as an advantage for smallholder farmers. This is the strategic imperative that policymakers are confronted with; the need to make technology adoption attractive to facilitate positive present experiences, which can result in the subsequent future adoption of technology. This study, therefore, acknowledges the relevance of past and present experience in facilitating technology adoption in the agricultural sector. During the collection of empirical data, respondents will be examined with respect to the influence and usage of past and present agricultural technology and how likely that will affect future adoption of agricultural technology.

4.3.2 PU and ATA

The first relationship explored in the conceptual framework in Figure 4.1 is the link between Perceived Usefulness (PU) and ATA amongst smallholder farmers. This relationship is vital as the extant literature hints at various studies which have supported the notion that perceived usefulness results in technology adoption (Caffaro et al., 2020; Tavitiyaman et al., 2022). Some studies (e.g. Chen & Aklikokou, 2020) reveal that perceived usefulness is a requisite factor that facilitates the adoption of new technology. When individuals perceive a technology to be useful to their work tasks and roles, it encourages them to be willing to learn and adapt the technology in the working environment. Perceived usefulness is key to overcoming resistance to change and other cultural or inhibiting factors which hinder or prevent technology adoption. According to Taufik and Hanafiah (2019), perceived usefulness requires an individual's psychological evaluation of a technology to determine whether or not the adoption of the technology can provide any benefit or use to the individual.

Perceived usefulness in the agricultural sector refers to the appraisal of a technology in terms of its use in enhancing agricultural productivity (Tsai, Cheng, Tsai, Hung & Chen, 2019; Izuagbe, Ifijeh, Izuagbe–Roland, Olawoyin & Ogiamien, 2019). It has been established that agricultural technology aims to improve efficiency and effectiveness, ultimately geared towards boosting farm yields and output (Sun et al., 2020). Agricultural technology is therefore applied or adopted to facilitate better performance from farmers. To smallholder farmers, a technology is only worth adopting if it has the potential to improve productivity and yield (Mukasa, 2018; Abdul-Rahaman, Issahaku & Zereyesus, 2021). Caffaro et al. (2020), in a recent publication, found that Perceived Usefulness (PU) had a positive effect on the adoption of Smart Farming Technologies (SFTs). Their study proved once again that farmers' perception of a technology is vital to its adoption. Perceived usefulness has also been mentioned in other studies on ATA as having a pronounced effect on technology adoption (Obiero, Waidbacher, Nyawanda, Munguti, Manyala & Kaunda–Arara, 2019; Kamble et al., 2019). Venkatesh et al. (2003) state that perceived usefulness greatly affects consumers' behavioural intentions regarding technology adoption.

This study applies the findings of previous studies on the role of perceived usefulness to smallholder farmers' adoption of agricultural technology. This study argues that there cannot be technological adoption if smallholder farmers are not made aware of the potential benefits the adoption of agricultural technology can have on their operations, particularly their produce and harvest. Perceived usefulness is a psychological element of consumer behaviour that motivates individuals to adopt new technology based on the perception that the use of the technology will offer benefits that will transform the current state of the individual (Zhao, Wang, Li, Zhou & Li, 2021; Kavaandi & Jaana, 2020). Perceived usefulness can determine whether or not farmers will be willing to embrace a new technology (Aubert, Schroeder & Grimaudo, 2012; Zheng et al., 2018). Pierpaoli, Carli, Pignatti and Canavari (2013), in a systematic review of precision ATA, discovered that one of the prominent factors accounting for the adoption of precision agricultural technology amongst farmers was perceived usefulness.

In the agricultural sector, perceived usefulness gains its relevance as a factor influencing smallholder farmer adoption of agricultural technology because it is one of the driving forces behind behaviour change (Chavas & Nauges, 2020; Ambalov, 2021). Therefore, farmers are more inclined to adopt agricultural technology if they perceive it as useful. However, some studies have already established the averseness of some farmers to agricultural technology (Barham, Chavas, Fitz, Salas & Schechter, 2014). This attitude is largely due to cultural norms and past experiences with technology. It can only be overcome if farmers are educated on the relevance of using new technology, with practical demonstrations of how technology adoption can result in socio-economic benefits (Brick & Visser, 2015; Mao et al., 2019).

From the conceptual framework in Figure 4.1, this study argues that perceived usefulness can positively and significantly impact ATA. This notion is supported by evidence from the works of Caffaro et al. (2020), who adopted the variable in assessing farmers' intention to adopt technological innovations in Italy. In their study, Caffaro et al. (2020) found that personal sources and non-personal sources of information impacted perceived usefulness and the intention to adopt agricultural technology. A farmer's intention to adopt new technology can be influenced by the source of information and its ability to convince the farmer of the benefits or perceived benefits the adoption of a technology can have on farming operations (Cafarro et al., 2020; Salimi et al., 2020).

Wang, and Wood (2021) assessed the influence of perceived usefulness in ATA in a study on farmers' adoption intentions towards diversified crop rotations in the United States of America. Their findings confirmed that farmers were willing to adopt new practices and technology if they perceived that the new technology could enhance their yield. Other studies have also identified perceived usefulness as a predictor of ATA and found that Unmanned Aerial Vehicles (UAV) technology was accepted due to the positive relationship between perceived usefulness and farmer's intention to adopt the technology for the application of pesticides in China (Zheng et al., 2018). The study by Zheng et al. (2018) demonstrated that farmers were willing to embrace UAV technology once convinced of its utility and benefits in pesticide application. This finding suggests that the greater the perceived usefulness of a technological innovation, the easier it is to stimulate adoption intentions amongst farmers.

From a Ghanaian contextual perspective, some studies on technology adoption in the agricultural sector have hinted that the perceived usefulness of a new technology plays an important role in farmer evaluation of the risk of adopting the technology (Theis, Lefore, Meinzen–Dick & Bryan, 2018; Adams et al., 2021). For example, Martey, Wiredu, Etwire, Fosu, Buah, Bidzakin and Kusi, (2014) explored the adoption and use intensity of Fertiliser application amongst smallholder farmers in Ghana and noted that when farmers perceived a new practice as relevant and beneficial to their farming operations, they were more open to its adoption. Baffoe-Asare, Danquah and Annor-Frempong (2013) also noted that the technology's relevance and application drove technology adoption in the Ghanaian agricultural sector. Farmers are perceptive individuals who carefully consider various effects before adopting new practices (Doss & Morris, 2000; Anang, Bäckman & Sipiläinen, 2020). As a result, one of the factors that can drive their intention to use new technology is when the technology and its features are perceived to be useful and have conspicuous benefits to offer (Weyori, Amare, Garming & Waibel, 2018).

Danso-Abbeam and Baiyegunhi (2017) sought to determine the factors influencing smallholder cocoa farmers' adoption of agrochemical inputs in Ghana. In their study, one of the major findings was that the decision to adopt agrochemicals was due to the perception of agrochemicals' benefits, especially in relation to soil fertility and increased yield. Their study further reinforces the notion that farmers will adopt a technology if there is compelling evidence demonstrating the perceived benefits of adopting the new technology. In a related study by Issahaku and Abdulai (2020), it was found that many farmers in Ghana were leaning towards the adoption of climate-smart practices due to the perceived usefulness of these technologies. Issahaku and Abdulai (2020) gathered compelling evidence which proves that when smallholder farmers in Ghana are educated on the benefits of agricultural technology and its impact on their farming activities, they are likely to be amenable to the adoption and use of the technology.

Due to the variations in farmer response to new technology, Ayisi, Kozári and Krisztina (2022) examined the differences in smallholder farmers' adopter categories. They found that smallholder farmers do not belong to a homogenous innovation adopter category. In other words, smallholder farmers do not respond in the same manner to the adoption of new technology. However, one conspicuous finding was that when the perceived usefulness of innovation is high, smallholder farmers who embrace risk and have a positive attitude towards innovation are likely to adopt the technology. Evidently, despite the variations in personal and contextual factors amongst smallholder farmers, the intention to adopt agricultural technology is positive when there is a clear reason to believe in the usefulness of the technology and the transformational effect on farming practices and outcomes (Anang, 2018; Danso-Abbeam et al., 2020). Perceived usefulness, therefore, represents an important predictor of ATA, and this present study seeks to test for its impact in the Ghanaian agricultural sector. Given the above discussions, the study proposes the following hypothesis: *H1: PU positively influences ATA amongst smallholder farmers.*

4.3.3 PEOU and ATA

The adoption of technology in the agricultural sector has always been a process inundated with many challenges (Verma & Sinha, 2018; Nwokoye, Oyim, Dimnwobi & Ekesiobi, 2019). Farmers have resisted various technological advancements, mostly due to a lack of understanding of the nature and use of technology (Wubeneh & Sanders, 2006; Barham et al., 2014). The issue of complexity has also been a strong deterrent to technology adoption among smallholder farmers (Moser & Barrett, 2006; Kumar et al., 2018). Perceived Ease of Use (PEOU) has therefore emerged as an important factor contributing to technology adoption in the agricultural sector. This study is hypothesised as one of the factors contributing to the adoption of agricultural technology by smallholder farmers in Ghana. Brosnan (1999) claims that PEOU is a psychological construct influencing how an individual responds to a new technology. The perception of smallholder farmers regarding how easy or difficult a new technology can be used may affect the adoption rate of the technology (Batz, Janssen & Peters, 2003; Takahashi et al., 2020). Perceived ease of use directly pertains to the degree of complexity of an innovation and how users perceive they can adapt to the technology (Pannell, 1999; Hörner, Bouguen, Frölich & Wollni, 2022).

Generally speaking, smallholder farmers in developing economies like Ghana are perceived to have limited education, making them often not enthusiastic about adopting new technology due to cultural beliefs, social norms and existing farming practices (Tsinigo & Behrman, 2017; Assan, Suvedi, Olabisi & Bansah, 2020). Nonetheless, previous research indicates that PEOU can be instrumental in changing the attitude of smallholder farmers toward technology adoption (Ankrah, Kwapong, Eghan, Adarkwah & Boateng-Gyambiby, 2021). Studies by Danquah, Twumasi and Asare (2019) and Obiero et al. (2019) in Ghana and Kenya reveal that the perceived level of difficulty in using a technology can influence smallholder farmers' decision to adopt new technology. Both studies found that PEOU was instrumental in driving adoption intentions for new technology amongst smallholder farmers. Nwokoye et al. (2019) also explored the socioeconomic determinants of communication technology adoption amongst smallholder rice farmers in Nigeria. They found significant evidence pointing to the influence of perceived ease of use on the adoption intentions of smallholder farmers.

Perceived ease of use strongly predicts the adoption of technology in general and in the agricultural sector (Asare-Nuamah & Mandaza, 2020). The effects of PEOU on ATA have been examined by scholars such as Zhou and Abdullah (2017), Ouko, Mukhebi, Obiero and Opondo, (2022) and Victor, Nic and Xiaomeng (2021). These studies found that perceived ease of use of agricultural technology was one of the significant factors accounting for the adoption of agricultural technology amongst farmers. This evidence confirms that it is reasonable to project that smallholder farmers in Ghana are likely to adopt agricultural technology if they have cause to believe that the technology is easy to use and can be handed with some form of education and orientation. On the other hand, the perceived complexity of new innovations often deters technology adoption amongst smallholder farmers (Ruf, 2011; Appiah & Guodaar, 2022). This perceived complexity is the antithesis of perceived ease of use and limits the adoption intentions of smallholder farmers (Kpienbaareh, Kansanga, Yiridoe & Luginaah, 2022). Critically, the degree to which a new technology is perceived as easy to use, handle and maintain is vital to adoption intentions, especially in the agricultural sector.

Various studies in the extant literature present a compelling argument which indicates that smallholder farmers are not entirely averse or deliberately resistant to new technology; they are, however, reluctant to adopt technology that is perceived to be sophisticated and difficult to use (Ricketts, Turvey, & Gómez, 2014; Teye & Quarshie, 2022). Therefore, driving technology adoption amongst smallholder farmers will require a more deliberate and intentional effort to demonstrate the perceived ease of use of agricultural technology. Agricultural technology differs from other forms of technology due to the context within which it is applied (Ayisi et al., 2022).

As such, it is essential that these technologies are designed to be as easy to use as possible, especially owing to the already-known fact that smallholder farmers do not possess vast educational qualifications that enable them to adapt to new practices, systems or technology easily. Even in mainstream technology adoption, consumers have been found to struggle with using complex technology (Rogers, 1995; Rogers, 2000). Several studies have found that complexity lowers adoption intentions amongst individuals, whilst perceived ease of use amplifies adoption intentions (Kapoor, Dwivedi & Williams, 2014; Clohessy, Acton & Rogers, 2019).

The relationship between PEOU and the adoption of technology can be described as a positive one; when users perceive that a technology is simple and easy to use, they become attuned to the reality that the technology's adoption and use can bring them more benefits and less stress (Acheampong, Siiba, Okyere & Tuffour, 2020). This is largely due to the fact that some consumers have invested significantly in new technology only to return the technology after finding it difficult to use (Duarte & Pinho, 2019; Dehgahni, Acikgoz, Mashatan & Lee, 2022). In the agricultural sector, the adoption of technology is already perceived as a difficult activity due to many personal, social and contextual factors (Kebebe, 2019). Therefore, in diffusing new technology in the agricultural sector, one feature that scholars have advocated for is perceived ease of use (Hung-Chou, Te–Yung & Su–Hui, 2018; Verma & Sinha, 2018). Perceived ease of use is vital to new technology promotion. When there is the perception that a technology is simple to use, there is a positive attitude which results in positive intentions to use the technology (Flett et al., 2004). On the other hand, a negative relationship is established when the technology is perceived as difficult to use (Jiminez, García, Violante, Marcolin & Vezzetti, 2020).

The adoption of technology by smallholder farmers can be greatly enhanced by the inclusion of perceived ease of use as a feature of agricultural technology (McDonald et al., 2016; Verma & Sinha, 2018). This study argues that in the Ghanaian context, the perceived ease of use of new technology, such as mobile money payment systems, has resulted in unprecedented rates of technology adoption, even to the extent that banks in Ghana felt threatened by the huge volumes of money and transactions being undertaken by telecommunications networks (operators of mobile money systems) and made several appeals to policymakers such as the Bank of Ghana to regulate the system to ensure that banks also had their share of the revenue from mobile payment systems (Oteng, 2019; Dzogbenuku, Amoako, Kumi & Bonsu, 2022).

The success of mobile money payment systems in Ghana, amongst all adopter categories, demonstrates that the adoption rate will rise significantly when a technology is easy to use. Smallholder farmers have widely adopted mobile money payment systems in Ghana (Peprah, Oteng & Sebu, 2020; Abdul-Rahaman & Abdulai, 2022). This shows that smallholder farmers are likely to adopt technology that can be easily used and navigated. The essence of perceived ease of use is to reduce cognitive dissonance and anxiety associated with new technology adoption (Batista & Vicente, 2020; Diaz, Sasaki, Tsusaka & Szabo, 2021).

Scholars have, over the years, found that consumers tend to develop anxiety and other psychologically related feelings related to technology adoption (Yang & Forney, 2013). In addition, previous experiences with complex technology also create barriers to adopting technology and future usage intentions (Shen, Huang, Chu & Hsu, 2010). Consequently, in the absence of perceived ease of use, individuals are likely to be stuck with negative associations emanating from previous use of technology. This often creates a situation where an individual is less likely to be an innovator and adopt technology upon its introduction.

Ayisi et al. (2022) found that smallholder farmers do not have similar tendencies regarding technology adoption. Smallholder farmer groups have various adopter categories, implying that receptivity to new technology will likely vary from person to person (Ayisi et al., 2022). The common denominator amongst smallholder farmers in relation to the adoption of new technology is perceived ease of use. PEOU is an important behavioural factor that determines whether or not a smallholder farmer will adopt or reject a technology (Asravor et al., 2022).

Various scholars have attested to the positive effects of PEOU on the adoption of agricultural technology (Khoza et al., 2021). This study also makes a strong case for the positive relationship between PEOU and ATA. In this study, the argument being made is that a positive and significant effect exists between PEOU and the adoption of agricultural technology amongst smallholder farmers. This relationship is predicated on the fact that the level of simplicity a technology possesses will make it easier for farmers to be willing to adopt and use the technology (Verma & Sinha, 2018; Kanuna & Ngari, 2021). Also, the lower the complexity involved in using an agricultural technology, the higher the intention to adopt the technology will be (Danquah et al., 2019; Khoza et al., 2021). PEOU's influence on individual adoption of technology in the agricultural sector leads to the following hypothesis:

H2: PEOU has a positive and significant effect on smallholder farmer adoption of agricultural technology.

4.3.4 Peer influence and ATA

Peer influence represents one of the greatest factors that contribute to the adoption or rejection of agricultural technology (Sampson & Perry, 2019; Chavas & Nauges, 2020). The farming community is thought to be a group of closely connected individuals who share common goals, beliefs and methods (Cole & Fernando, 2021). As such, the degree of connectivity amongst such a group can influence group norms towards the adoption of agricultural technology. Previous evidence confirms the vital role of peer influence in dictating the adoption and acquisition of new farming methods (Kumar et al., 2018; Adnan et al., 2019). However, most research on the adoption of agricultural technology (Feder & Slade, 1984) focuses on the head of the household as the only decision-maker.

Recent studies draw attention to the broader social setting where adoption decisions occur (Doss, 2006) by focusing on the family unit instead of the individual head of the household. The ageing farm population is one reason why this shift of focus from the head of household occurred. Asfaw et al. (2004) capture the effects of differing education levels within a family unit by including in their analysis the family member with the highest education level other than the head of household. Barham et al. (2014) investigate access to family labour by incorporating the age of family members other than the head of household involved in farm management. These studies account for formal knowledge by incorporating the number of years of education (Anderson, Wilson & Thompson, 1999; Wozniak, 1993; Bjornlund, Nicol & Klein, 2009).

Empirical evidence from these studies indicates that education is positively related to the probability of adoption; the argument put forth is that educated farmers are more likely to adopt on-farm irrigation technology because they are better equipped to select and assimilate first-hand information and analyse the future outcomes of their investments. The literature has also shown that, regarding the costs and benefits of irrigation technology, government disseminate technical information to farmers in at least four ways: travel to individual farms talking to managers, demonstrations, field days, and meetings. Contact with extension services is a common proxy for access to public information. Doss (2006) reports two quantitative measures of access to information that most studies in the field have used: the number of extension visits and whether or not a farmer received any extensions.

A few studies have investigated the role of informal farmer knowledge in farmers' decision-making for adopting agricultural technology. Feder & Slade (1985) and Smith, Felderhof and Bosch (2007) show that farmers who invest in more effective irrigation technology do so as a result of word-of-mouth recommendations. In other words, according to Federer et al. (1985), farmers mostly seek advice from other farmers. According to this view, the interaction between farmers fosters ATA. Most research on this topic (Feder et al., 1984; Asfaw et al., 2004; Barham et al., 2004) focuses on the family unit in the decision-making process. Building on the theoretical concepts that externalities are to be found in the broader social and cultural contexts of farmers' decision-making (Feder et al., 1984; Umali, 1993), further work is needed to understand the social factors that influence the flow of knowledge that may lead to technology adoption. In view of that, the following hypothesis is proposed: *H3: Peer influence positively and significantly predicts ATA amongst smallholder farmers in Ghana.*

4.3.5 Superior influence and ATA

The literature on technology adoption has acknowledged that apart from peer influence, the influence of superiors can also determine whether or not an individual adopts new technology or otherwise (Barnes et al., 2019; Zakaria et al., 2020; Zhang et al., 2020). Superior influence comprises the pressure and deliberate actions from a supervisor or person in charge, which ensures that an individual complies with and adopts new technology for use at work or within a working environment (Sampson & Perry, 2019; Pathak et al., 2019).

Technological communication occurs through various networks with diverse conditions where human interaction shapes technology diffusion. Covering an array of networks improves our understanding of the structure, dynamics, and influence that different social settings have on technology diffusion. Furthermore, each type of social network impacts technology diffusion differently because relations between individuals involved with technology occur in diverse social contexts.

Professional collaboration can take place in three social settings: kinship relations (family), landowner-tenant relations (work), and affiliations (social associations) in adoption decisions. Kinship relations refer to relations between members of the same extended family involved in farming. A significant body of literature focuses on the family as a determinant of technology adoption (Brown et al., 2019; Llewellyn & Brown, 2020). This leads to reason to believe that individuals within the network of smallholder farmers can influence their adoption of agricultural technology. Even though the smallholding farmer environment is vastly different from corporate settings where a hierarchy of authority within organisations bestows certain power, authority and rank on individuals making them “superiors”, there are still certain individuals within the agricultural smallholding farming community who are considered as “superiors”, in relation to their experience and number of years practising agriculture (Kumar et al., 2018; Sarker et al., 2020).

Morris and Venkatesh (2000) found that age differences among colleagues could influence opinions toward the adoption of technology. Individuals tend to defer to older colleagues, making them more receptive to advice, suggestions and influence (Zhang et al., 2019). Graf-Vlachy et al. (2018) found that the influence of individuals in a superior position in organisations and communities played an important role in influencing individuals towards technology adoption. Superiors in the workplace are revered and given a certain status among colleagues (Mallmann, Maçada & Eckhardt, 2018; Brachten, Kissmer & Stieglitz, 2021).

This makes them important opinion leaders, and the same can be said for smallholder farmers. Superior influence in the context of smallholding farming can refer to the various individuals whose influence extends beyond their family into the community and possibly even into other larger professional associations and bodies (Yadegaridehkordi, Nilashi, Shuib & Samad, 2020). In the agricultural sector, superior influence can play a role in driving smallholder farmers towards the adoption of agricultural technology.

A review of the extant literature reveals that the Decomposed Theory of Planned Behaviour (DTPB) conceptualised subjective norms as comprising of two types of influences; peer and superior influences (Sadaf & Gerzer, 2020; Zaman, Zahid, Habibullah & Din, 2021). Subjective Norms are the set of beliefs an individual possesses which pertain to how a certain behaviour will be accepted by important people within the individual's social or work setting (Garay et al., 2019; Yan, Zhao, Zhang, Deng & Zhang, 2022). The concept of subjective norm demonstrates that individuals are influenced by the actions, opinions and thoughts of people around them (Adnan et al., 2019).

Studies have found that even though social influence predicts technology adoption, superior influence also determines whether or not an individual is likely to accept or reject a technology (Chen, 2020). In this study, superior influence is hypothesised to positively and significantly affect smallholder farmers' adoption of agricultural technology. This position is informed by the fact that subjective norms have been found to influence behaviour greatly, and superior influence is an aspect of subjective norms that can similarly profoundly impact an individual's behaviour (Elahi, Khalid & Zhang, 2022).

In the agricultural sector, superior influence comprises established and experienced farmers' influence on their counterparts with few years of experience and a lower scale of operations (Chavas & Nauges, 2020; Ullah et al., 2020; Cao, Zhao, Qian & Xiang, 2022). Superior influence can also comprise individuals such as agricultural extension officers, who are perceived to have a high degree of knowledge and skill on matters concerning agricultural technology and the performance of crops and livestock (Alexander, Greenhalgh, Moglia, Thephavanh, Sinavong, Larson & Case, 2020; Streletskaya, Bell, Kecinski, Li, Banerjee, Palm-Forster & Pannell, 2020). These individuals can induce others (farmers and stakeholders) in the agricultural sector to adopt new technology. Superior influence has a slight advantage over social influence because, unlike social influence, superior influence is often regarded as a higher form of opinion or approval (Campenhout, 2021).

The literature on technology adoption recognises the positive effect of the influence of superior social networks on ATA (Jha et al., 2020). Various studies have confirmed the positive and significant effect of superior influence on the adoption of farm-based technology (Li et al., 2021). The opinions of important superiors in smallholder farming can influence others to form attitudes and develop behaviours that lead to the adoption of agricultural technology (Emmanuel, Owusu–Sekyere, Owusu & Jordaan, 2016; Nyarko & Kozari, 2021). The role of extension officers has been highlighted as an example of superior influence which contributes to the development of behavioural intentions towards the adoption of new technology (Azumah & Adzawla, 2017; Amankwah & Quagrainie, 2019).

Agricultural extension officers provide knowledge and skill-based transfer services to smallholder farmers, and their opinion can constitute superior influence which can contribute to technology adoption. Similarly, experienced farmers and stakeholders in the agricultural sector, such as chiefs and other traditional rulers, can also constitute superior influence and stimulate smallholder farmers' desire to adopt new technology. Crabbe, Standing, Standing and Karjaluoto (2009) stated that superior influence was a strong predictor of intention to adopt mobile technology in Ghana. The present study acquiesces with this perspective and further avers that the same effect can be achieved in the agricultural sector if superior influence is operationalised as a predictor of ATA. Consequently, the following hypothesis is proposed: *H4: Superior influence is positively and significantly related to ATA amongst smallholder farmers in Ghana.*

4.3.6 Attitude and ATA

In this study, attitude is the first personal factor in the adoption of behavioural elements, which is hypothesised to influence smallholder farmer adoption of agricultural technology. Attitude is a psychological and personal construct that pertains to how individuals evaluate and respond to the world around them (Massoro & Adewale, 2019; Zossou, Arouna, Diagne & Agboh–Noameshie, 2020). An Individual’s attitude can influence their decision-making and behaviour, as many scholars have found over the years (Cafarro & Cavallo, 2019). In the agricultural sector, this is no different. This study theorises that the attitude of smallholder farmers can determine whether or not these farmers will adopt or reject a new agricultural technology. Some studies have acknowledged that the attitude of farmers towards new technology has an important link to their behavioural responses. For instance, Fishbein and Ajzen (1975) discovered that a person's attitude determines his or her outlook, particularly when it comes to evaluating outside stimuli and developing behaviours. Ajzen and Fishbein (1980) also noted that an individual’s attitude towards an object could determine whether or not the item in question will be liked or disliked, favoured or rejected.

In the case of technology adoption, a farmer’s attitude towards new inventions such as seed variety, irrigation systems, planting styles, and new equipment may determine whether they adopt any of these new innovations (Knierim, Kernecker, Erdle, Kraus, Borges & Wurbs, 2019). As a result, farmers are often torn between maintaining the status quo and sticking with established practices or adopting new behaviour to embrace new technology (Chavas & Nauges, 2020; Li et al., 2021).

Adopting new technology is influenced by a farmer's attitude, as a negative attitude or perception towards the technology can result in a negative behavioural response

(Shang, Heckelei, Gerullis, Börner & Rasch, 2021). Recent studies have found that positive attitudes result in positive behaviours, whilst negative attitudes have an adverse effect on behaviour (Dadzie, Ndebugri, Inkoom & Akuamoah–Boateng, 2022; Elahi et al., 2022). The debate regarding the influence of attitude on consumer behavioural intentions has been studied over the years. Most studies conclude that the key to eliciting a desired behaviour is to ensure that the individual has a positive attitude towards the idea, product, service or change agent (Cavallo, Ferrari, Bollani & Coccia, 2014; Nyairo, Pfeiffer, Spaulding & Russel, 2022).
Attitude is a psychological construct comprising an individual's perception of an objective (Ajzen, 1991; Hrubes, Ajzen & Daigle, 2001). An individual's attitude can be favourably or unfavourably inclined towards an object. As a result, consumer behaviour scholars have warned firms to invest in attitude formation before initiating behaviour change initiatives (Madden et al., 1992). For example, in the agricultural sector, evidence points to failed technological inventions that did not receive enthusiastic adoption rates due to poor perception and attitude (Bagheri, Bondori, Allahyari & Damalas, 2019; Alavion, Allahyari, Al–Rimawi & Surujlal, 2017; Senger, Borges & Machado, 2017). This clearly establishes the fact that for farmers and other stakeholders in the agricultural sector to adopt a new technology, they would need to first develop a positive attitude towards it (Fishbein & Ajzen, 1975; Edison & Geissler, 2003; Yamano, Rajendran & Malabayabas, 2015; Alavion et al., 2017).

Cavallo et al. (2014) found that attitude was a key determinant of the adoption of technological innovations in the agricultural sector. This reinforces the notion by scholars such as Ajzen and Fishbein (1980), who averred that when an individual's attitude determines whether or not they will like or dislike a concept, idea, person or technology. Therefore, attitude is an important personal factor influencing consumer behaviour (Colémont & Van den Broucke, 2008). This has been widely established in the consumer behaviour literature, leading to a reasonable postulation that, in a similar vein, the attitude of smallholder farmers can determine their adoption decision towards agricultural technology.

Interestingly, Willock, Deary, McGregor, Sutherland, Edwards-Jones, Morgan, ... and Austin (1999) report that an individual's attitude is formed based on what the individual considers to be true or false, suggesting that the attitude is linked to the worldview and perception of the individual. Established cultural norms, family experience, and community agricultural practices in smallholder farming can influence an individual's attitude towards new technology adoption (Tiraieyari & Krauss, 2018; Savari & Gharechaee, 2020).

Attitude is instrumental to technology adoption because attitude influences human behaviour. Therefore, if a smallholder farmer has a positive attitude towards, for example, irrigation technology, then it is likely that they will adopt this technology (Meijer et al., 2015; Tama, Ying, Yu, Hoque, Adnan & Sarker, 2021). Attitude is a sensitive factor in predicting ATA, and this is because many factors can impact smallholder farmers' attitudes. In a recent study by Dadzie et al. (2022), the authors investigated the risk attitudes of smallholder cassava farmers in Ghana and sought to unearth the implications of technology adoption. It was found that social interactions and trust in social networks could result in a positive attitude that could result in a favourable response to adopting new technology (Dadzie et al., 2022).

ATA is a decision-making activity, and like all decision-making processes, information is an important component which shapes the attitude and influences the final purchase decision (Fuchigami, Tuni, Barbosa, Severino & Rentizelas, 2021). Goodarzi, Masini, Aflaki and Fahimnia (2021) claim that technology adoption can be enhanced when individuals receive the right information at the right time. In diffusing new technology, manufacturers and promoters need to ensure that consideration is made for information dispersion to stimulate attitudinal change because, in the absence of that, a negative reaction and behaviour are likely to occur. Fishbein and Ajzen (1975) have found that attitude is responsible for behaviour, which is reflected in individuals' decisions and choices. Therefore, in the agricultural sector, farmers' attitudes largely influence the response to agricultural technology. This claim is supported in technology adoption studies, as many researchers have found a link between consumer attitude and technology adoption (Faisal, Chunping, Akhtar, Raza, Khan & Ajmal, 2020).

Chuang, Wang and Liou, (2020) studied farmers' knowledge and attitude towards technology adoption and found that attitude was an important variable that was positively related to and contributed to technology adoption. Rogers (1995) argued that knowledge and attitude were two key determinants of technology adoption. An individual's attitude towards technology could play a key role in the eventual decision to adopt or reject the technology. This study argues that the attitude of smallholder farmers in Ghana can impact their adoption of agricultural technology. Adrian, Norwood and Mask (2005) previously found that attitude was significantly related to the adoption of agricultural technology. Other studies have similarly highlighted the potential role of attitude on technology adoption in the agricultural sector (Liu, 2013; Adnan et al., 2017; Adnan et al., 2019; Zulqarnain, Sharifuddin, Roslan & Hassan, 2020).

Zulqarnain et al. (2020) found that farmers with a positive attitude towards technology were not reluctant to adopt and use new technology. However, their study also found that the individual's attitude towards technology depended on several factors, such as education level, knowledge, and years of experience in agriculture. The findings of Zulqarnain et al. (2020) study confirm that attitude has a relationship with technology adoption in the agricultural sector. Kaler and Ruston (2019) also investigated the relationship between farmers' attitudes and behavioural intentions to use precision technology. They found that the beliefs of farmers influenced their attitudes, which resulted in negative adoption rates and responses to precision technology in livestock farming (Kaler & Ruston, 2019). The beliefs of livestock farmers sampled by Kaler and Ruston (2019) were that hands-on interaction with the animals was an essential part of the role of a good stockman, and irrespective of the potential benefits of precision technology, the fact that it would replace the hands-on interaction resulted in an unwillingness to embrace the precision technology.

In another study by Morris, Henley and Dowell (2017), farmer attitude was found to be a predictor of technology adoption. This conforms to previous studies in the agricultural sector and makes a strong case for the predictive power of attitude as a variable influencing the adoption of agricultural technology (Borges, Lansink, Ribeiro & Lutke, 2014). Some authors have also highlighted the role of attitude in technological adoption decision-making (Bhageri et al., 2019).

The general consensus is that the attitude of farmers towards technology adoption depends on the knowledge they acquire or are exposed to in relation to the technology (Zeweld, Van Huylenbroeck, Tesfay & Speelman, 2017). Therefore, if the technology is diffused successfully, and farmers acquire knowledge that boosts their self-efficacy, it can contribute to developing a positive attitude towards technology adoption. Attitude can therefore be construed as an important construct resulting from knowledge and belief formation (Chin, Choong, Alwi & Mohammed, 2016).

The information an individual has about a new technology can contribute to positive attitude formation, making an individual more inclined to adopt new technology (Hansson, Ferguson & Olofsson, 2012). Fishbein and Ajzen (1975) highlighted three processes that result in the formation of beliefs, subsequently resulting in the development of an attitude. These processes are observation, inference and informational belief from external sources (Fishbein & Ajzen, 1975). The perceptions smallholder farmers have about an innovation are very closely linked to the knowledge they possess about the technology (Shiferaw, Okello & Reddy, 2009; Lowitt, Hickey, Saint Ville, Raeburn, Thompson–Colón, Laszlo & Phillip, 2015). In that vein, it is reasonable to assert that the knowledge and perceptions about an innovation determine an individual's attitude towards the adoption of the technology.

Some studies have found that there are numerous extrinsic variables which contribute to the formation of knowledge and attitudes. These extrinsic variables are classified into three categories, namely: (1) Characteristics of the farmer, (2) Characteristics of the external environment, and (3) Characteristics of the innovation (Abebe, Bijman, Pascucci & Omta, 2013; Alexander et al., 2020). The majority of scholars who have investigated the role of attitude in technology adoption have concluded that knowledge, attitudes and perceptions towards technology adoption are largely influenced by the characteristics of the farmer (Jellason, Baines, Conway & Ogbaga, 2019). A farmer's personal attributes, such as age, gender, marital status and income, education and social networks, can influence attitude towards technology adoption (Zaremohzzabieh, Krauss, D'Silva, Tiraieyari, Ismail & Dahalan, 2022).

Positive attitudes emanate from exposure to knowledge and can result in a strong correlation with the intention to adopt technology (Chuang et al., 2020). This study, therefore, postulates that the attitude of smallholder farmers can be positively related to their adoption of agricultural technology. This proposition is anchored on the reality that a smallholder farmer's evaluation of the benefits of a new agricultural technology contributes to the attitude they develop towards the adoption of the technology (Yang, Zhou & Deng, 2022). If the knowledge acquired contributes to a positive attitude, then it is likely that the farmer will adopt the technology. Based on the overwhelming evidence that exists, this study makes the following proposition: *H5: Attitude positively and significantly predicts ATA amongst smallholder farmers in Ghana.*

4.3.7 Self-Efficacy and ATA

Another factor this study theorises to influence the adoption of agricultural technology amongst smallholder farmers is self-efficacy. Over the years, researchers studying the factors influencing technology adoption have pointed out that self-efficacy is one of the many factors that influence the adoption of technology (Irby & Strong, 2013; Sharifzadeh et al., 2017). Self-Efficacy is one of the personal factors determining whether an individual will adopt new technology. In this study, the role of self-efficacy in the adoption of agricultural technology is considered. According to Venkatesh and Bala (2008, p.274), "Self-efficacy is defined as an individual's beliefs regarding his/her ability to use IT." The perception of an individual in relation to their degree of competency to use information technology represents the concept of self-efficacy. Self-efficacy is personal because it results from an individual's evaluation of their capabilities as far as the use of a technology is concerned. This suggests that the greater an individual's self-efficacy, the more likely they are to adopt a new technology. Conversely, the lower an individual's self-efficacy, the less likely they are to adopt a technology.

The role of self-efficacy in ATA cannot be understated or ignored. Smallholder farmers have certain limitations which may impact their self-efficacy as far as the adoption of agricultural technology is concerned (McGinty et al., 2008; Castiblanco Jimenez, Cepeda García, Marcolin, Violante & Vezzetti, 2021). These limitations and challenges often pertain to educational background, access to credit and funding, personal development, land ownership and household management (Jayne et al., 2010; Aliber & Hall, 2012). If these contextual factors create a belief of inadequacy in the mind of the individual, it is likely that there will be a negative attitude towards technology adoption.

However, suppose a farmer's self-efficacy is high due to years of experience in agriculture, similar experience or success in adopting related technology, and encouragement from social, superior or peer influence. In that case, the farmer is more likely to adopt new technology. Therefore, self-efficacy's role in technology adoption in the agricultural sector is a phenomenon worth investigating. This study conceptualises self-efficacy as one of the adoption behavioural dimensions that can influence ATA.

Bandura (1986, p.360) explained the concept of self-efficacy as "…judgment of one's ability to use a technology to accomplish a particular job or task." This description of self-efficacy portrays the concept as a personal factor that can also be a psychological factor affecting an individual's behaviour concerning technology adoption. Scholars have found that when self-efficacy is high, it breeds confidence, which is more likely to result in technology adoption than when self-efficacy and confidence are low (Bukchin & Kerret, 2020; Saha, 2022). Bandura's (1986) definition of self-efficacy clarifies that it is the extent to which an individual assesses their capability to use a technology to achieve their goals. It becomes clear when this concept is applied to the activities of smallholder farmers in the agricultural sector that they are more likely to accept a technology if they believe they are capable of employing it (Syan, Kumar, V., Sandhu & Hundal, 2019; Li & Xue, 2022).

Delving into the literature on smallholder farmers, one fact that cannot be disputed is that most smallholder farmers received training and apprenticeship often from family and previous generations of farmers within the family setting, and this made them accustomed to the kind of technology that was being used (Kreft, Huber, Wüpper & Finger, 2020; Mir & Padma, 2020). Moving on to adopt new technology without years of acclimatisation can therefore be a challenging and daunting proposition for smallholder farmers. Scholars such as Igbaria (1995) have found that self-efficacy is positively correlated to the acceptance of technology innovations and information technology systems. Unfortunately, smallholder farmers in developing countries are often not frequently exposed to new technology in the agricultural sector, creating a culture of aversion or fear towards new technology (Joshua, 2020). However, some researchers have found that even though a personal factor, self-efficacy can be influenced by education, training and orientation (Atabek, 2020; Adamovic, Gahan, Olsen, Gulyas, Shallcross & Mendoza, 2022).

The self-efficacy of a smallholder farmer is crucial to their adoption of new technology, and this is why many recommendations have been made for stakeholders in the agricultural sector to provide an enabling environment and resources which can help build the confidence and self-efficacy of smallholder farmers (Wu & Mweemba, 2010; Burnham & Ma, 2017). For example, in a recent study by Zobeidi, Yazdanpanah, Komendantova, Sieber and Löhr (2021), self-efficacy was listed as one of the key factors influencing the technical and non-technical adaptation of smallholder farmers to drought-related technology usage in

Iran. Similarly, Wuepper and Lybbert (2017) found that self-efficacy plays an important role in helping smallholder farmers overcome poverty and adopt technology for economic development.

In a study conducted in Ghana, Wuepper and Sauer (2016) investigated the role of self-efficacy in the performance of contract farmers in Ghana. Their study discovered that self-efficacy and social capital played an important role in smallholder farmers' integration into pineapple farming in Ghana. Wuepper and Sauer (2016) concluded that self-efficacy and social capital were defined and influenced by historical factors and past experience, and this feeds into the earlier argument made in this section which posited that smallholder farmers develop self-efficacy from past experiences with “mentors” or family heads who nurtured them in the area of agriculture and farming practices.

The ability of a smallholder farmer to be successful not just in technology adoption but also in farming depends largely on their belief in themselves and their ability to be successful in whatever they aspire to do (Venkatesh & Bala, 2008; Wuepper & Sauer, 2016). Scholars have, over the years, established that self-efficacy is a psychological and behavioural construct which explains the nature of individuals and their attitudes towards risk (Rezaei, Mohammadi, Asadi & Kalantary, 2008; Bandura, 2012; Irby & Strong, 2013). The more confidence an individual has, the more likely they are to take certain risks, which can positively influence outcomes in any field of endeavour. This can be applied in the agricultural sector as self-efficacy can be the difference between a smallholder farmer’s decision to adopt or reject a new technology. According to Bandura (1997), the degree to which an individual believes in themselves determines the extent to which they will be willing to embrace change, knowing that the change may be good and better than what was previously experienced. However, individuals with low self-efficacy have self-inhibiting tendencies often borne out of low self-esteem and confidence.

In this research, the link between self-efficacy as a personal adoption behavioural dimension and ATA is hypothesised as being positive if the self-efficacy of the smallholder farmer is high. The higher the self-efficacy, the greater the likelihood of the smallholder farmer adopting new agricultural technology. This proposition is based on extensive research confirming the positive impact of high-self efficacy on technology adoption within the agricultural sector (McGinty et al., 2008; Rezaei et al., 2020; Zarafshani, Solaymani, D'Itri, Helms & Sanjabi, 2020). Scholars have established that self-efficacy is an instrumental factor impacting the decision of smallholder farmers to adopt new technology (Khai & Dung, 2020; Sun & Mei, 2022). This is unsurprising, as a review of the extant literature on technology adoption has highlighted the role of self-efficacy in promoting positive and proactive adoption behaviours (Miller & O'Khera, 2010; Chen et al., 2011; Sharifzadeh et al., 2017).

Technology adoption in the agricultural sector is a complex activity that does not always result in the desired outcome for all stakeholders involved (Irby & Strong, 2013; Sharifazadeh et al., 2017). However, self-efficacy can play an important role by increasing the adoption rates for agricultural technology. For example, Compeau and Higgins (1995) and other scholars such as McGinty et al. (2008) have found compelling evidence suggesting that a farmer's belief that they can use technology to achieve their farming goals and objectives has a positive effect on the adoption of new technology. In fact, other scholars have also learned that when a farmer's self-efficacy is high, there is confidence that adopting new technology will not hinder but rather boost agricultural performance (Wu & Mweemba, 2010; Wuepper & Lybbert, 2017).

This study advances the argument that self-efficacy can positively affect ATA. Wu and Mweemba (2010) studied environmental self-efficacy and behaviour among smallholder farmers in Zambia. They concluded that the environmental self-efficacy of farmers could influence their behaviour and contribute to behaviour change. They further found that when farmers had a greater sense of belief, awareness and confidence in their capabilities, they were more likely to adapt to new technology and use it to achieve their objectives, which most often increased yield and productivity.

There are other studies whose findings lend further support to the postulation that self-efficacy positively impacts ATA. For instance, the recent study by Kavandi and Jaana (2020) sought to determine which factors impacted technology adoption and discovered that self-efficacy was a key factor influencing technology adoption. The mounting evidence on the role of self-efficacy in the technology adoption literature suggests that even in the context of agriculture and amongst smallholder farmers, self-efficacy can play a great role in influencing technology adoption. Kohnke, Cole and Bush (2014), for instance, found that when individuals possess high levels of self-efficacy, they are able to complete tasks using available resources. This finding suggests that individuals with self-efficacy make the best of every situation. In the context of agriculture, smallholder farmers who possess self-efficacy are likely to be more attuned towards the notion of technology adoption in order to improve farming output.

Self-efficacy has been operationalised in past studies as a direct or moderating variable influencing the behavioural intentions of individuals with respect to technology adoption (de Veer, Peeters, Brabers, Schellevis, Rademakers & Francke, 2015; Kohnke et al., 2014; Lu et al., 2014). These studies all reported positive outcomes and effects of self-efficacy on technology adoption. This gives further impetus for the present study to conceptualise and operationalise self-efficacy as one of the adoption behavioural dimensions responsible for ATA amongst smallholder farmers in Ghana. The role of self-efficacy as a variable that predicts ATA is not dependent on the age of individuals, as scholars such as de Veer et al. (2015) have found that self-efficacy was positively related to technology adoption and usage intentions amongst older people. This means that when applied to the context of the agricultural sector, older farmers can also adopt agricultural technology if they possess or develop self-efficacy. Therefore, Self-efficacy stands out as one of the personal factors that influence and can contribute to adopting agricultural technology amongst smallholder farmers in Ghana. Based on this, the following hypothesis is proposed: *H8: Self-Efficacy is positively related to ATA amongst smallholder farmers in Ghana.*

4.3.8 Complexity and ATA

Complexity is a personal factor that influences ATA. Past studies have examined the link between complexity and ATA and found a link between these two variables (De Janvry, Macours & Sadoulet, 2017; Pathak et al., 2019; Ali et al., 2022). Complexity impacts the degree of technological adoption by influencing user response and attitude to the adoption of the new technology (Fisher, Norvell, Sonka & Nelson, 2000; Moser & Barrett, 2008). Some scholars claim that complexity is a factor which hinders technology adoption and usage intentions (Glover et al., 2019). In the agricultural sector, researchers have found that smallholder farmers often adopt technologies that are easier to use or less complex (Doss, 2001; Pathak et al., 2019). This makes it imperative that new technologies overcome the limitations of complexity in order to be able to facilitate seamless adoption amongst smallholder farmers. Moser and Barrett (2006), for example, found that the degree of complexity of agricultural technology and the ease of adaptation and learning influenced the adoption of technology amongst smallholder farmers.

Complexity as a factor influencing technology adoption can have two effects; the degree of complexity of an agricultural technology can either hinder or facilitate technology adoption (Sassenrath, Heilman, Luschei, Bennett, Fitzgerald, Klesius & Zimba, 2008; Hörner et al., 2022). This study makes a case for the latter effect as ATA has been found to improve the productivity, performance and yield of smallholder farmers (Vecchio et al., 2020). By implication, when smallholder farmers are able to adopt technology, and adapt to its features, it is likely to have a positive effect on their activities. However, the obstacle to such an outcome is technological complexity, which has dominated the adoption literature over the years due to its unavoidable effect on the adoption process (Glover et al., 2016; Manalo, Pasiona & Bautista, 2022).

Wilkinson (1989) made an important finding in relation to complexity and its role in ATA. Wilkinson (1989, p.1) states, “Complex technologies have been regarded previously as monolithic: adopted as a whole, but more slowly than simpler technologies.” Based on this assertion, complex technologies can be in the form of entire systems or component parts of systems that can be adopted separately or as a whole. Wilkinson (1989, p.1) confirmed this and further stated, "…a complex technology is redefined as one which can be broken up into separate technological components, each of which may be adopted separately.” Therefore, in the context of smallholder farmers, it is important to identify the nature of the technology being promoted within the agricultural sector in order to determine how to successfully diffuse the technology to the target group (smallholder farmers) without magnifying the complexity of the system.

Researchers have found that the more complex a technology is, the less likely it is that smallholder farmers will adopt it (Van den Berg, 2013; Manalo et al., 2022). This can even be more pronounced when technology adoption manifests itself as a complex stepwise system that requires smallholder farmers to go through different phases of adoption. In the absence of extensive education and orientation, it is likely that any attempt to migrate smallholder farmers from their old ways of doing things to new methods, systems and technology may fail or produce less than optimal results (Challa & Tilahun, 2014). Wilkinson (1989:1) further stated that *“…adoption of a complex technology, as defined, occurs in a stepwise manner. Components are adopted in some order, which reflects the adopter's perception of their value to his operation. Not all components are taken up by all adopters.”*

This statement lends credence to the arguments being established in this thesis. However, it is not always the case that every aspect or phase of technology adoption will be embraced by the target market, or in the context of this study, by smallholder farmers. There are many obstacles, and the complexity of a technology is one of them. This study, therefore, seeks to establish the causal effect of complexity as an influence on the adoption of technology amongst smallholder farmers.

Further evidence supporting the postulation that complexity influences the adoption of technology in agriculture was found in the study by Kumar et al. (2018), who investigated factors driving aquaculture adoption. In their study, Kumar et al. (2018, p.1) established that "…some of the critical factors that influence aquaculture technology adoption decisions such as (1) method of information transfer, (2) characteristics of the technology, (3) farm characteristics, (4) economic factors, and (5) sociodemographic and institutional factors." Amongst these factors, the technology's characteristics best explain the role of complexity in technology adoption.

Kumar et al. (2018, p.451) found that "The characteristics of the technology itself clearly play an important role in a farmer's decision to adopt a new technology. However, that decision is more complex than it might appear on the surface." This statement highlights the nature of complexity even when deciding to adopt a new technology. Per Kumar et al.'s (2018) assertion, if a technology shares the characteristics of being complex, the rate of adoption is likely to be low. On the contrary, if the features of the technology are easy to understand, use and transfer, then it is more likely that the technology will be adopted.

Other researchers support the notion that reduced complexity can positively influence consumer perception and the decision to adopt new technology (Lambrecht, Vanlauwe, Merckx & Maertens, 2014; Feyisa, 2020). For instance, Pannell, Marshall, Barr, Curtis, Vanclay and Wilkinson (2011) found that a technology has a higher success rate if its relative advantage is higher than its perceived degree of complexity. The adoption of technology is undoubtedly made easier when the said technology appears to have more benefits than complexities, and this is a key determinant of ATA because farmers often tend to prefer working with less complexity and with more certainty and guarantee of competitive advantage (Awotide et al., 2016; Feder & Savastano, 2017).

Scholars such as Rogers (1995) have, over the years, argued about the nature of complexity and opined that the complexity of an innovation has a negative relationship with adoption. Roger (1995) further explained that the higher the degree of complexity, the lesser the chance that a technology will be adopted. This view has been established and gained widespread acceptance in the literature on technology adoption, which makes it difficult to neglect in discussions on factors that influence or impact the adoption of technology, especially in the agricultural sector. Interestingly, the literature has acknowledged some of the personal limitations of smallholder farmers, especially in developing economies. For example, the lack of extensive formal education is one factor contributing to the aversiveness towards agricultural innovations that have a high degree of complexity (Rogers et al., 2005; Kapoor et al., 2014; Atkin, Hunt & Lin, 2015).

Other factors such as culture, social influence, and more do certainly impact the decision to adopt technology, but the literature presents a compelling case for the inclusion of complexity as one of the major factors that contribute to this phenomenon (Pick, Gollakota & Singh, 2014; Yoon, Lim & Park, 2020). As such, in this study, the researcher aims to test for the effect of complexity as a personal factor influencing technology adoption amongst smallholder farmers in Ghana.

Wilkinson (2006) maintained that for successful ATA, stakeholders would need to work together to ensure that the degree of complexity is reduced. Barroga (2010) made a similar claim in the study on the adoption of multi-component and preventive rice production technologies and noted that farmers tended to be apprehensive when the degree of complexity was higher than they were used to. In simple terms, complexity always stimulates feelings of anxiety among farmers, and this is largely due to the perception that complex agricultural technologies may do more harm than good (Drape, Westfall-Rudd, Doak, Guthrie & Mykerezi, 2013; Lindner, Rodriguez, Strong, Jones & Layfield, 2016).

Farmers, by nature, are committed to routines, culture and patterns and are less likely to redesign or embrace a technology that leads them on a drastically different path in terms of planting, fertilizing or harvesting unless confronted with overwhelming evidence otherwise (Murray, Gebremedhin, Brychkova & Spillane, 2016; Danso-Abbeam et al., 2020). Of course, inherent complexity cannot be avoided in some technological innovations. However, the fundamental issue at stake is that due to the already inverse relationship between complexity and technology adoption, it would be prudent if manufacturers of agricultural technology consider the extent to which a technology's complexity may hinder the adoption of the technology. For example, Pullin (1993) found that farmers in Panama and Malawi adopted integrated aquaculture practices due to the low degree of complexity.

Similarly, Doss (2001) found that reduced complexity is a key imperative when designing technology for use in the agricultural sector. These views are echoed by Pathak et al. (2019), who found through their systematic review of factors affecting farmers' adoption process, including the degree of complexity, which had a more profound effect than other factors. Clearly, the evidence suggests that the relationship between ATA and complexity is inverse, which can only be positive if the degree of complexity is low. This study, therefore, argues that for smallholder farmers in Ghana, there is likely to be an acceptance of new agricultural technology if the degree of complexity is minimal.

This study theorises that, like in other places in the world that have confirmed the influence of complexity in ATA (Aubert et al., 2012; Kumar et al., 2018), smallholder farmers in Ghana are similarly likely to be affected by the nature of complexity that is inherent in agricultural innovation. This belief is anchored on existing studies which provide indisputable evidence that technologies are adopted more quickly when beneficiaries perceive that they are easy to use (Danquah et al., 2019; Diaz et al., 2021; Khoza et al., 2021).

The effect of complexity on ATA is also exacerbated due to the fact that the agricultural industry, to a large extent, is manned by smallholder farmers who, based on personal and contextual factors, typically prefer to adopt less-complex innovations (Verma & Sinha, 2018; Bagheri et al., 2021). As such, the more a technology appears to be complex, the less favourable response it is to receive from smallholder farmers.

This is in contrast to other fields, such as engineering or even medicine, where complex new technologies are required to solve existing or new problems and, as a result, are embraced more quickly by engineers, contractors and medical personnel (Marks & Thomas, 2022). In agriculture, farmers are more conservative and tend to have a negative attitude towards complex agricultural technology (Shehzad, Ibrahim, Yusof, Khaidzir, Khurshid & Othman, 2020). Henderson and Clark (1990) observed that complexity differs from one innovation to the other and depends on whether an innovation is radical or incremental. The conclusion based on Henderson and Clark's (1990) study is that technologies that are incremental tend to gain faster adoption rates than radical innovations.

Innovations in agricultural technology that require huge and significant adaptation and learning are perceived as disruptive in a negative light and consequently receive little attention from smallholder farmers. Joffre, Klerkx, Dickson and Verdegem (2017) found this to be true. They posited that the degree of complexity in new technology must be considered carefully to prevent lower adoption rates. This further confirms all the previous discussions, highlighting the effect of complex technologies on smallholder farmers' adoption of agricultural technology. In view of the overwhelming evidence which points to the effects of complexity on technology adoption in the agricultural sector, the following hypothesis is proposed: *H7: Complex agricultural technology has a negative effect on ATA.*

4.4 CHAPTER SUMMARY

This chapter discussed the conceptual framework of this study and examined the various path relationships and effects leading to ATA. The conceptual framework was illustrated and presented in Figure 4.1, and the various components of the framework were elaborated on in relation to the extant literature. The discussions included the baseline relationship between the independent and dependent variable and the multiple pathways comprising of the various elements of adoption behavioural elements. This chapter further presented a review of pertinent literature supporting the causal relationships resulting in the formulation of the various hypotheses of the study. The chapter that follows elaborates on the research methodology which serves as the plan of action adopted in this study.

CHAPTER FIVE

RESEARCH METHODOLOGY

5.1 INTRODUCTION

The previous chapter discussed the conceptual framework and highlighted the key causal relationships being tested. Finding a solution to the research topic can be aided by applying the correct and appropriate theories, methodologies, and research abilities (Panneerselvam, 2014. This chapter expounds on the various methodological considerations that influence the conduct of this empirical study on ATA amongst smallholder commercial farmers in Ghana. In this chapter, the various methods commencing from the philosophical perspectives to the ethical principles and considerations are examined. The research approach, research design and strategy are also deliberated in this chapter. Further, the population of the study is defined, leading to the identification of an appropriate sampling technique for selecting respondents for the study. Further discussions pertaining to the source of data collection, the instrument for data collection and the process are also presented. This chapter, therefore, contributes to the thesis by explicating the various elements of research methodology that were selected to facilitate the empirical collection of data from smallholder farmers to achieve the objectives of the study.

Figure 5.1 depicts the graphical view of research philosophies, interlinked with the many assumptions and procedures in the complete research process, for a full comprehension of the various stages of the methodology related to the research philosophy.

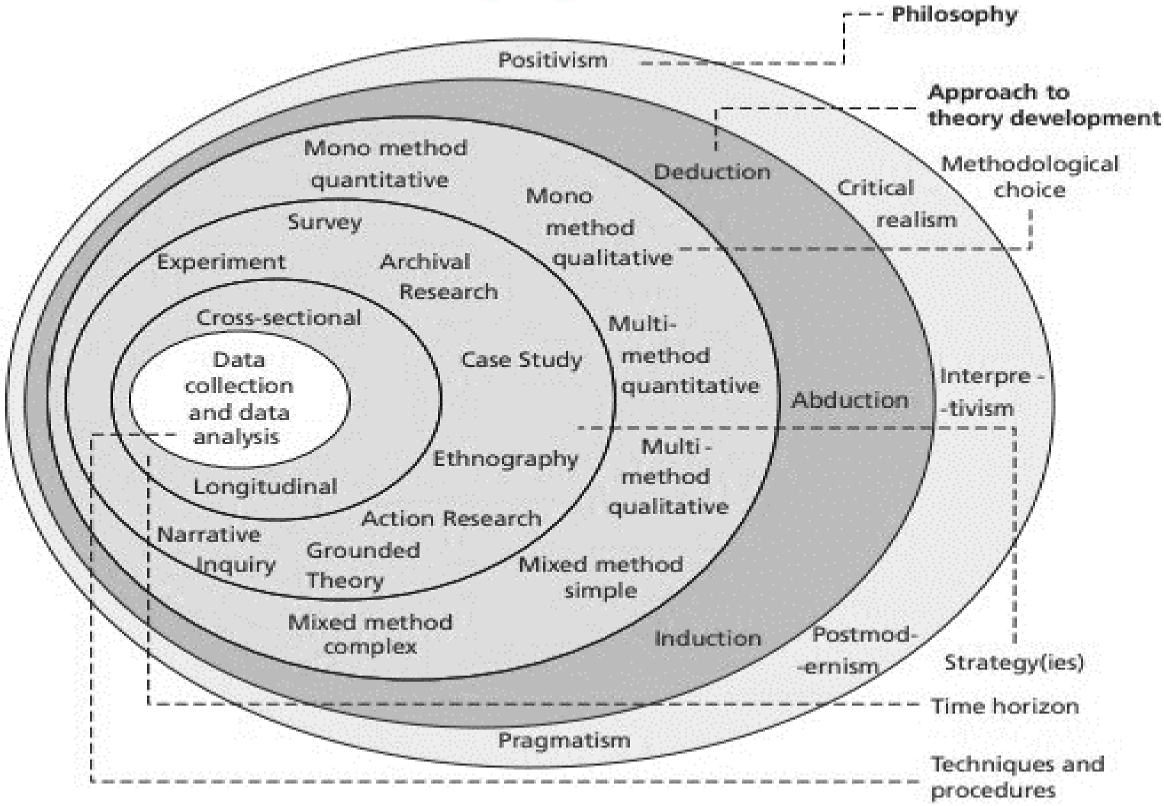


Figure 5.1: Research Onion

(Saunders, Lewis & Thornhill, 2019:130)

5.2 COMPETING PHILOSOPHICAL PERSPECTIVES

Research philosophy also known as research paradigm is an important feature of discussions on research methodology (Ryan, 2018; Tamminen & Poucher, 2020) because it is important in appropriate handling of other methodological issues in the research process (Bhatta, 2018; Hürlimann, 2019).

In this section, the various competing research philosophies or paradigms are discussed and the one adopted is explicated and justified. In other words, this section focuses on the philosophy chosen and its underlying assumptions that guide and affect the selection of other research methodologies in researching the adoption of agricultural technology by farmers in Ghana.

Philosophical aspects of research relate to ontology, epistemology and axiology. Following sections discuss these aspects with emphasis on the ones that apply to the current research.

5.2.1 Ontology

Researchers including Weber (1993), Uschold and King (1995), Crotty (1998), Snape and Spencer (2003) and Richards (2003) concur that ontology refers to the study of 'being' and is concerned with the nature of existence, the structure of reality or what constitutes knowledge. In short, ontology can be viewed as the beliefs about the nature of reality and the social world that exists.

Al-Saadi (2014) distinguished between constructionism and objectivism as the two primary ontological frameworks. This research adopts the objectivist belies about how true knowledge must be created. According to ontological objectivism, reality can be viewed accurately and directly, and there is a distinct difference between what we believe about the world and how the world is. Reality is said to exist independently of our views and understanding. It makes the assumption that only the physical or material world can be regarded as "real" and that social processes and their interpretations are static (Al-Saadi, 2014; Snape and Spencer, 2003; Crotty, 1998).

On the other hand, the constructionism (subjectivism) ontological position also assumes an external reality but can only be known through social constructions (subjective constructions) and the human mind. According to this position, there is no shared social reality, only a variety of individual constructions that make reality subjective. Additionally, the constructionism ontology contends that there are only approximate or estimated observations or perspectives of reality and that social phenomena and their interpretations are always being revised as a result of social interaction (Al-Saadi, 2014; Ormston, Spencer, Barnard & Snape, 2014; Bryman, 2008; Snape & Spencer, 2003; Crotty 1998). This philosophy was not used in this research

5.2.2 Epistemology

Al-Ababneh (2020) defines epistemology as the theory of knowing or how true knowledge can be created. So, while ontology deals with the “what”, of research, epistemology deals with the “how” part. The two broad epistemological positions are positivism and interpretivism. Therefore, "the nature of human knowledge and understanding that may be attained through various forms of inquiry and alternate techniques of examination" is what the term epistemology refers to (Hirschheim, Klein & Lyytinen, 1995:20).

The epistemological position known as positivism corresponds to objectivism which asserts the veracity of a theory by a guiding objective reality. This research follows the positivist tradition. On the other hand, the interpretivists argue that there is no truth waiting to be discovered and no meaning without a mind (Crotty, 1998, Al-Ababneh, 2020). Therefore, interpretivist epistemological viewpoint refers to the meaning that arises in and out of human contact with the realities in the world. This viewpoint corresponds to subjectivism. This indicates that the subject is imposing its meaning on the object, not the object itself (Crotty, 1998, Al-Ababneh, 2020).

This study follows the positivist beliefs. This choice and justification are explicated in the section titled research paradigm.

5.2.3 Axiology

Axiology is derived from the Greek words “logos”, which means theory or reason, and “Axios”, which means "having value" and is a term that refers to a theory of desired values (Yulianto, 2021). Value can be seen as a science to analyse potential action in practice and eliminating negative influences and strengthening positive ones (Yulianto, 2021; Saunders, Lewis & Thornhill, 2019). The term "axiology" describes the significance of the researcher's morals and ethics throughout the research (Saunders, Lewis & Thornhill, 2019). A key axiological choice researchers make is how much they want to consider the impact of their values and beliefs on the research as beneficial (Saunders, Lewis & Thornhill, 2019). Axiologically, research can be value free or value laden. From the earlier definitions, it is obvious that the objectivist ontology and the positivist epistemology align with the value free axiology while the subjectivism and interpretivism align with value laden axiology. These bipolar distinction leads to what is termed research paradigm. On the one hand, there is the positivist paradigm that subscribe to objectivism and value free research while interpretivism aligns with subjective and value laden research,

This research is embedded in positivism hence conforms to the value free axiology. Positivism which is the chosen paradigm for this research is now discussed in detail. This discussion will be followed by brief overview of the other paradigms not adopted.

5.2.4 The positivism paradigm

Positivism is the research philosophy that advances the objective ontology that focuses on how researchers can use theory and hypotheses testing approaches to discover new knowledge (Ryan, 2018). Positivists contend that reality is steady and amenable to observation and objective description (Levin, 1988). According to this theory, researchers cannot meddle with the phenomena they are studying; as a result, the phenomena should be isolated, and the findings should be repeatable. This frequently entails altering reality by changing just one independent variable to find patterns in and establish connections between some of the components of the social world (Hirschheim, 1985). Hirschheim (1985) asserts that positivism is so deeply ingrained in our society that knowledge claims that are not based on it are simply dismissed as being unscientific and invalid. Positivism is quantitative in nature, and it inspires researchers to measure and analyse research issues using statistical methods based on well-established theoretical principles (Corry, Porter & McKenna, 2019; Park, Konge & Artino, 2020). Quantitative research is also known as empirical research (Hinchey, 2008), deductive, and explanatory (Saunders, Lewis & Thornhill, 2009; Engel & Schutt, 2005).

In this study, the positivist paradigm was chosen to examine the relationships between the consumer behavioural dimensions and agricultural technology adoption. This philosophy was adopted because there are established theoretical foundations explaining the concept of technology adoption. This study adopted a multi-theory testing approach to explore the relationship between the consumer behavioural elements and agricultural technology adoption amongst smallholder farmers in Ghana. The positivist philosophy was also adopted because it believes in the premise that reality can be measured through hard and observable facts. This study adopted this philosophy to determine how consumer behavioural elements can help improve the adoption of agricultural technology amongst smallholder farmers in Ghana.

5.2.5 Interpretivism

Interpretivism or phenomenology is another theoretical perspective that contradicts positivism to understand and explain human and social reality (Al-Ababneh, 2020). Interpretivism is a research philosophy that holds that there are multiple realities which can be captured through close interaction between the researcher and respondents (Ryan, 2018). Neelankavil (2007) states that Interpretivists claim that reality can only be fully grasped by human interpretation and intervention. According to interpretivists, scientists cannot help but impact the things they research. They acknowledge that there could be numerous ways to interpret reality, but they insist that each is a component of the scientific understanding they are pursuing. Interpretivism holds a subjective ontology and uses qualitative approaches, which are more flexible than positivist-inspired quantitative approaches (Ryan, 2018; Irshaidat, 2022). The qualitative research approach is also known as exploratory research (Neelankavil, 2007; Engel & Schutt, 2005; Bernard, 2006), inductive (Saunders et al., 2009; Engel & Schutt, 2005) and formulative (Khotari, 2006).

According to Al-Ababneh (2020), the interpretivism paradigm is not a suitable strategy for generalizing findings because of how people's interpretations change over time and how complicated and unique the world is. The study acknowledges that social science research is complicated and does not lend itself to theorising by a set of laws like other scientific studies. Instead, interpretive studies look for significance in human activity. Moreover, as it investigates actual events, it is unique in how it approaches research design, concept creation, data analysis, and standards of assessment (Al-Ababneh, 2020). This paradigm was not followed.

5.2.6 Critical Realism

A more subtle form of realist ontology is introduced by critical realism, which is largely based on the writings of Bhaskar (1989) and others (Archer, Bhaskar, Collier, Lawson & Norrie, 1998; Fleetwood, 1999; Sayer, 1992). It is typically considered a compromise between positivism and interpretivism (Zachariadis, Scott & Barrett, 2013). Nevertheless, ontology is given much weight in critical realism, which backs the notion that reality exists regardless of our knowledge or perception of it (Archer et al., 1998; Bhaskar, 1989). Critical realism also allows for a degree of epistemological relativism, where the process of scientific knowledge is viewed as historically emergent, political, and imperfect (Smith, 2006). Both the positivists and interpretivists approaches are believed to be valuable for attaining the research objectives. Critical realism embraces various methods (Venkatesh et al. 2013; Wynn & Williams 2012; Downward & Mearman 2003; McEvoy & Richards 2006; Mingers 2005; Mingers & Gill, 1997). One study combines qualitative and quantitative approaches with the mixed method approach (Zachariadis, Scott & Barrett, 2013).

An alternative philosophy to critical realism is pragmatism. Critical realism and pragmatism have different underlying tenets, but the former is a rival ideology to the latter (Elder-Vass & Zotzmann, 2022). A research philosophy known as pragmatics suggests that researchers use various techniques to find reality and the truth (Johnson & Onwuegbuzie 2004). In pragmatism, the researcher can employ various techniques to address urgent research questions (Biesta 2010; Creswell & Clark 2011). According to Tashakkori and Teddlie (1998), the pragmatist research philosophy entails the adoption of a methodological approach that is flexible and that allows researchers to explore multiple perspectives. In addition, pragmatism focuses on achieving research objectives by embracing diverse data collection methods (Maarouf, 2019; Kelly & Codeiro, 2020). This philosophy was also not followed.

5.3 RESEARCH APPROACH

Research approaches determine how researchers find evidence to determine research questions (Creswell & Creswell, 2017; Bergin, 2018). For Saunders and Thornhill (2019:130), research approach refers to how one goes about (the reasoning process in) developing a theory. These authors classify these approaches as deductive, inductive and abductive reasoning. These ways of reasoning respectively correspond to the quantitative, qualitative and mixed methods of research which leads some to classify research approach as quantitative approach, qualitative approach, and mixed method approach. The preference is to use the deductive, inductive and abductive nomenclature.

Deductive, inductive and abductive approaches are the three research approaches that have been widely used by researchers (Taguchi, 2018; Mertens, 2019). Each approach brings a unique set of benefits and constraints and entails understanding the underpinning research philosophy and its application (Mertens, 2019; Leavy, 2022). This study follows the deductive approach. Although the inductive and abductive approaches are not used in this study, they are briefly discussed. A full discussion of the deductive approach and the justification for its choice follows in the next session. Inductive (qualitative) studies are influenced by interpretivist philosophy and entail using descriptive and narrative tools to collect and analyse data (Slaney & Tafreshi, 2018; Leavy, 2022). An inductive (qualitative) approach enables researchers to use interviews, focus group discussions and observations on capturing a phenomenon or research issue. The abductive (mixed methods) approach entails the use of both deductive and inductive reasoning (qualitative and quantitative methods) to achieve research goals (Creswell & Creswell, 2017;

Bergin, 2018). Mixed methods are viewed as a strong research approach due to its ability to triangulate data from multiple sources to measure a research issue (Mertens, 2019; Leavy, 2022). The mixed methods approach combines qualitative and quantitative approaches and thus gives the researcher a more holistic perspective of a phenomenon (Hong, Gonzalez-Reyes & Pluye, 2018).

5.3.1 Deductive approach (quantitative research)

The process of collecting and analysing numerical data is known as quantitative research and corresponds to the deductive approach. This approach involves formulating hypotheses, examining causality, and extrapolating findings to larger populations (Ryan, 2018; van der Langenberg, Kocevska & Luik, 2022). The deductive reasoning is the process of collecting data to quantify information and use it in statistical analysis to either confirm or disprove opposing knowledge claims (Kocevska & Luik, 2022). This means theory testing based on data collection and analysis. Thus, theory shapes the research (Neuman, 2014; Ryan, 2018; van de Langenberg et al., 2022).

To achieve the aims and objectives of this study, the deductive (quantitative research) approach was selected. This approach was chosen because the adoption of behavioural dimensions has been established in the extant literature and can be measured through statistical means. Also, technology adoption as an outcome variable has received some attention from researchers who have operationalised the concept quantitatively. This study, therefore, used the deductive (quantitative) approach to determine the relationship between the consumer behavioural dimensions and ATA behavioural dimensions amongst smallholder commercial farmers in Ghana.

5.4 RESEARCH DESIGN

Research designs refer to general research frameworks that researchers rely on to develop questions used to obtain information regarding a research issue (Awang, 2012; Sreejesh, Mohapatra & Anusree, 2014). For example, three prominent research designs: exploratory research design, descriptive research design and causal research design (Remler & Van Ryzin, 2021).

The research methodology literature search shows that there are many ways to classify research design. Table 5.1 constitutes the major design types identified based on insights from Maxwell (2004); Sousa Driessnack and Mendes (2007); Fallman (2008); Scriven (2008); Glymour et al. (2008); Babbie and Mouton (2010); Jackson (2011); Brown and Suter (2012); Sreejesh et al. (2014); Ivey (2016); Creswell and Creswell (2017); Bergin (2018); Iacobucci and Churchill (2018); Siedlecki (2020); Dulock (1993); Siedlecki (2020); Carter, Andersen, Stagg and Gaunt (2022).

Table 5 1 Research design types

TYPE	PROCEDURE	INCLUSION
Experimental Design	A researcher decides the factor(s) that they will change and then measures the effect of this change on another variable. Key feature is random assignment. The researcher controls other factors that could influence the result, allowing determination of causality.	Not included
Quasi-Experimental Design	It is like experimental design but lacks random assignment. Instead of assigning subjects to a group randomly, they are put into groups based on predefined characteristics.	No
Descriptive Design:	This design describes phenomena as they exist naturally. No manipulation of variables occurs. It includes observational research, case studies, and surveys.	Yes
Correlational Design:	It examines the relationships between variables and how they might or might not change together. Correlation does not imply causation.	Yes

Explanatory Design	Often a follow-up to descriptive or exploratory research. Once a phenomenon has been identified, explanatory research uses inferential statistics to explain why or how the phenomenon happens.	Yes
Exploratory Design	This design is used when the subject of study is relatively new, and no prior research exists. The goal is to gain a general familiarity with the topic before undertaking more rigorous research. It involves literature surveys, interviewing experts, and perhaps some direct observation.	No
Longitudinal Design	A longitudinal study follows the same subjects over time and makes repeated observations.	No
Cross-Sectional Design	Cross-sectional research studies participants at one moment in time, providing a snapshot view of a phenomenon.	Yes

Own compilation

5.4.1 Choice of research design

A causal research design was chosen to investigate the effects of adoption behavioural aspects on smallholder commercial farmers' adoption of agricultural technology in Ghana. The causal research design was selected to enable a statistical analysis of the association between the adoption of agricultural technology and the various adoption behavioural dimensions, namely perceived usefulness (PU), perceived ease of use (PEOU), peer influence (PI), superior influence (SI), attitude (A), and complexity (COMP). The study aims to develop an ATA strategy for farmers to enhance the adoption of agricultural technology. As such, Structural Equation Modelling tools were used to analyse data collected from smallholder commercial rice farmers of Ghana.

The use of theory to create a conceptual framework that explains the causal linkages between the predictor and the criterion variable in this study was another reason why the causal research methodology was used. Adoption behavioural characteristics were the predictor factors, and ATA was conceptualised as a criterion variable. Descripto-explanatory studies are a type of research design that include descriptive and causal elements, as combined in this study (Saunders, Lewis & Thornhill, 2019).

The causal design was used to test the adoption behaviour models and relate it to the farmer's decision to adopt agricultural technology in order to propose methods to increase the adoption of agricultural technology. The adoption behaviour of smallholder commercial farmers is characterised and determined using consumer behaviour aspects to understand the psychological, social, and personal components of farmers and develop strategies for increasing the adoption of agricultural technologies. The study established this by using a descriptive research approach that allowed for a clear knowledge of farmer technology adoption behaviour. The descriptive methodology was solely used to examine the pre-existing hypotheses that underlie this study and confirm their applicability in both theory and practice in the area of technology adoption.

5.5 POPULATION AND SAMPLING

This section of the thesis addresses the study population, the sampling strategy used, and the process of calculating the sample size.

5.5.1 Target population

In research, population refers to the general group of individuals from which a sample is selected for research (Thomson, Rhoda, Tatem & Castro, 2020; Stratton, 2021). Population in research is the basis for sampling, as respondents are generally selected from the population (Manna & Mete, 2021). The target population is the entire group of items or components pertinent to the study project. The definition of the target population may be impacted by components including subject-matter expertise, element availability, and time constraints (Thomson et al., 2020; Stratton, 2021).

Smallholder commercial rice farmers in Ghana made up the study's general population, while a subset of them served as the target population. Specifically, the population for this study was rice farmers at the Weta Irrigation Scheme. According to document analysis, the population of farmers in the Weta Irrigation Scheme is 1,095. This number represents the general number of farmers who are part of the scheme.

The sample frame for the study (see Appendix IV) was the list of rice farmers at the Weta Irrigation Scheme under the Ghana Irrigation Development Authority (GIDA). The two primary rice cultivation schemes in the Volta Region are the Weta Irrigation Scheme in the Ketu North District and the Aveyime Irrigation Scheme in the North Tongu District. Small-scale farmers can benefit from GIDA's community-based irrigation infrastructure. The Weta Irrigation Scheme is part of the formal rice farming sector of the Ministry of Food and Agriculture. There are 11 sections to the Scheme. Except for Sections 1 to 4, which include 5 sub-Blocks, A to E, each Section is divided into four blocks, A to D. Weta Irrigation Scheme has 2,164.82 acres of farmed land, and 1,095 rice farmers, 76.6 percent of them are male and 23.4 percent female (Appendix A: Weta Irrigation Scheme - Summary List of Farmers).

5.5.2 Sampling

Another consideration in this section is the sampling technique which is the selection of individual participants to constitute the sample for the collection of data. A simple random sampling technique was used to select 285 participants from the 1,095 for the study. Sample refers to the group of individuals selected from a population for research purposes (Kyriazos, 2018; Vasileiou et al., 2018). In research, a sample is selected because no researcher can afford to collect data on the entire population unless in the case of a census (Vabalas, Gowen, Poliakoff & Casson, 2019; Hennink & Kaiser, 2021). Therefore, sampling is a crucial study component that must be addressed in order to prevent any errors or mistakes in a sample. There are two types of sampling techniques: probability and non-probability (Etikan et al., 2016; Sharma, 2017). Probability sampling techniques provide all respondents with an equal chance of being selected. On the other hand, non-probability sampling techniques do not give every respondent an equal chance of being selected. However, they are based on the researcher's discretion in selecting qualified respondents to participate in the research (McDaniel & Gates, 2018). Non-probability sampling is widely used in exploratory research design. The objective is to quickly and affordably gather data. Researchers who are not interested in generalising their findings to the entire population use non-probability sampling techniques (Sharma, 2017). The most suitable sampling approach for the research is probability sampling, which is determined by the research objectives and methods mentioned thus far. By using a probability sampling technique, it would be possible to confirm that each farmer at the Weta Irrigation Scheme in Ghana's Volta Region has a chance of being included in the sample and that they are all independent from one another (Pelham & Blanton, 2006). This is done in order to provide a sample that is truly representative of the target population, which is Ghana's smallholder commercial rice producers. The simple random technique was used in selecting respondents, and this was facilitated by the knowledge of the sampling frame, which made it possible to apply this probability sampling technique. Each farmer on the sample frame is given a sequential number (see Appendix IV). Then, using the Random Number Generator from Calculaor.net, a random selection of those numbers was made (see Appendix V for the randomly created numbers that represented the farmers interviewed). The Random Number Generator was given a range between 1 and 1095 to choose 285 integers at random, which served as the foundation for the study's participants.

5.5.3 Sample size calculation

Ahmad and binti Halim (2017) assert that sample size is crucial for financial considerations. A small sample study may be ineffective because it cannot yield relevant data. A larger-than-needed sample study, on the other hand, can consume more resources. The sample size for this investigation was calculated using Cochran's (1977) continuous sample size calculation followed by Bartlett II, Kotrlik and Higgins (2001). With this sample size, the error rate was 3%. For continuous data, this was an acceptable margin of error in social and educational research (Krejcie & Morgan, 1970).

Ahmad et al. (2017) identified three factors that need to be considered in determining the sample size: the confidence interval, which is the margin of error; the confidence level, and the standard deviation. The confidence interval measures the degree of uncertainty or certainty in a sampling method and how much uncertainty there is with any particular statistic. The confidence level refers to the percentage of probability or certainty that the confidence interval would contain the true population parameter when a random sample is drawn many times. Finally, the standard deviation measures a data set's distribution from its mean (Ahmad et al., 2017; Bartlett II, Kotrlik & Higgins, 2001; Krejcie & Morgan, 1970).

The researcher estimated the standard deviation, set the level of tolerable error at 3%, and the alpha level at.05 levels when determining the sample size for continuous data (Bartlett II, Kotrlik & Higgins, 2001; Krejcie & Morgan, 1970). Cochran's (1977) sample size formula for continuous data is:

$$n = \frac{t^2\ x\ s^2}{d^2} = \frac{(1.96)^2\ x\ \ (1.25)^2}{(5\ x\ .03)^2} = 266$$

Where:

- "t" is the value for a chosen alpha level of .025 in each tail = 1.96 when n or the sample size is more than 120, i.e., the alpha level of .05 shows the degree of risk the researcher is willing to take that the genuine margin of error may be greater than the allowable margin of error;

- "s" is an estimate of the population's standard deviation. The formula of s is: $s = \frac{5(number\ of\ points\ on\ the\ scale)}{4\ (number\ of\ standard\ deviations = 5-1)}$ and;
- "d" is the allowed error margin for the projected mean. The permitted error margin is 3% or .03 (bin Ahmed & binti Halim, 2017).

The technique yielded 266 responders, which is the minimal sample size needed. This sample size is simple to get with a captivated audience (Salkind, 1997). The response rates are, however, far below 100% because surveys and other data collection techniques were frequently used in many social research investigations. This study employed the survey method and complied with Salkind's (1997) advice to oversample or expand the sample size by up to 40% if the researcher uses a questionnaire (Ahmad et al., 2017). The sample size has been increased by 7%, as per Salkind (1997). Oversampling can increase survey costs, although it is frequently essential. This view agrees with Cochran (1997) assertion that the sample obtained using the abovementioned calculation is smaller than the intended sample. The determined sample simple is 266 respondents. When increased by 7%, the result is: $n = 266\ x\ 1.07\ = 285$

As a result, 285 respondents were used in the survey, and there was a 100% response rate. A sample of 285 rice farmers from the Weta Irrigation Scheme was taken for this study. The agricultural extension officers aided in distributing the questionnaire to a simple random sample of farmers. Some people immediately returned the completed questionnaire. A 100% retrieval rate for the 285 administered questionnaires was achieved through ongoing follow-ups with respondents, which allowed for retrieving all the questionnaires.

In addition to the Weta Irrigation Scheme, there is the Aveyime Irrigation Scheme in the Volta Region of Ghana. But the Aveyime Irrigation Scheme is fairly minor compared to the Weta Irrigation Scheme. It has 94 farmers and 54 hectares of farmland. A third scheme had already begun as of the time the data were collected. This scheme is called the Kpoglo Irrigation Scheme in the Ketu South District of the Volta Region. The farmers of the Weta Irrigation Scheme and the Kpoglo

Irrigation Scheme are essentially the same because of their close proximity. However, the Weta Irrigation Scheme's abundance of farmers and arable land and its far higher annual production than the other two combined were chosen for this study.

5.6 METHODS OF DATA COLLECTION

Primary and secondary data are two types of data that researchers can collect to achieve their aims and objectives (Clark & Vealé, 2018; Ruggiano & Perry, 2019). Primary data refers to new and original data that is collected based on new research gaps (Corti, Van den Eynden, Bishop & Woollard, 2019). Secondary data refers to data already collected by researchers to achieve some predetermined goals and objectives, which can be used for further analysis by other researchers (Busetto, Wick & Gumbinger, 2020; Gupta, 2022).

Primary data was collected in this study. The choice of primary data was predicated on the research problem and gaps, which justified the need for primary data that examines the relationship between consumer behaviour dimensions and agricultural technology adoption behavioural elements. A research strategy was adopted to carry out the research work. According to Saunders et al. (2009), research strategy entails a plan that stipulates how a researcher will conduct a study. Research strategies determine which elements a researcher needs to adopt to achieve their objectives (Clark & Causer, 2020). For qualitative studies, research strategies include case study, ethnography, grounded theory and phenomenology (Saunders et al., 2009; Creswell & Creswell, 2017). Examples of quantitative strategies are surveys, experiments and observations (Saunders et al., 2009; McDaniel & Gates, 2018). In this study, the survey strategy was adopted. Survey strategies are used for collecting large amounts of data from respondents. This study used the survey strategy to collect data by administering questionnaires to smallholder commercial farmers in the Weta Irrigation Scheme. Both the observational and experimental data collection methods are inappropriate for this study. Observational data are collected by systematically recording observations of people, events, or objects (Saunders et al., 2009; Creswell & Creswell, 2017). The adoption behaviours are psychologically inherent and cannot be observed physically as in the observational method. Likewise, experimental data collection involves the manipulation of one variable to determine its changes on another variable and is mostly related to laboratory test procedures (Saunders et al., 2009; Creswell & Creswell, 2017). This study was not purposed to conduct any such test.

The use of a questionnaire to collect data was required because of the study's objectives which informed the use of a quantitative research approach and a descriptive design. Therefore, a structured questionnaire was designed based on the research questions, the objectives and established scales from the literature. The questionnaire was composed of five sections.

An introductory part, a socio-demographic profile section, captures respondents' personal information. These include the number of years of farming, age, gender, religion, location, ethnicity, occupation, level of education, annual income from rice farming, marital status and the number of children. These variables were measured on nominal/categorical (gender, religion, location, ethnicity, occupation, marital status) and interval (number of years farming, age, annual income from farming, number of children) scales. The socio-demographic characteristics of respondents were adapted from Adnan et al. (2017), who studied the influence of Malaysian paddy farmers' adoption intention towards sustainable agriculture.

The second section focuses on farmers' psychological and behavioural elements and measures two dimensions: Perceived Usefulness (PU) and the Ease of Use (EOU) of agricultural technology. The Perceived Usefulness was measured by 11-items scaled with a Five-point Likert scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree). The Ease-of-Use construct was also measured with an 8-item scaled with a Five-point Likert scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree). Perceived Usefulness and Ease-of-Use constructs' items were adapted from the usefulness and ease-of-use of a technology adoption construct of Tubaishat (2017), whose research explored nurses' perceptions of usefulness and ease-of-use of electronic health records. They employed the Technology Acceptance Model (TAM).

The third part of the questionnaire is concerned with the social behavioural elements of respondents. Also, it measures two dimensions: Peer Influence (PI) and Superior Influence (SI) on respondents in agricultural technology adoption behaviour. The Peer Influence was measured by 8-items scaled with a Five-point Likert scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree). The Superior Influence construct was also measured with 8-items scaled with a Five-point Likert scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree). The items of both Peer Influence and Superior Influence were adapted from Taylor & Todd (1995c), who studied the impact of referents on normative beliefs in technology adoption and acceptance in information system research.

The fourth section deals with the personal behavioural elements of respondents in adopting agricultural technology. The personal behavioural characteristics were measured with three constructs: Attitude (A), Self-Efficacy (SE) and Complexity (COMP). Each of these three constructs was measured with 8-items scaled with a Five-point Likert scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree). The items of Attitude were adapted from Buabeng-Andoh (2018). The items of Self-Efficacy and Complexity items were adapted from Vakilalroaia and Fatorehchi, (2015).

The fifth section concerns respondents' adoption decisions to adopt agricultural technology. This construct was measured with 6-items scaled with a Five-point Likert scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree). Adoption (A) items were adapted from Buabeng-Andoh (2018). Overall, the questionnaire contained 65-items measuring all the major variables in the research.

The data was collected from smallholder farmers from the Weta Ir rigation Scheme. Consent letters were sent, and respondents were engaged initially via conversation to introduce the purpose and nature of the research and obtain dates for the administration of the data collection instrument (questionnaire). The initial interaction with the respondents proved to be helpful. The respondents expressed their inability to use the Google link to the questionnaire because of difficulty accessing the internet and not having smartphones. As a result, hardcopy printing of the questionnaire was agreed upon. Once the initial contact was established and consent sought, the researcher and two research assistants went to the location of the farmers. They spent the period of data collection at Avalavi in Weta. During this data collection period, the researcher, the two research assistants and two extension officers at GIDA Office at Avalavi, Weta, made constant follow-ups with respondents. The extension officers were employed because they knew the farmers and their homes to make follow-ups. The research assistants and the agricultural extension officers were adequately trained on the contents of the questionnaire and the processes and ethics of data collection. Those who could read and write were asked to complete the questionnaire and offer their responses. When a responder could not read or write, the research assistants and agricultural extension agents helped them complete the questionnaire by reviewing the questions with them. The 285 questionnaires that were distributed were all returned after the data-gathering process took more than two months.

5.7 VALIDITY AND RELIABILITY

Due to the quantitative approach adopted in this study, the researcher checked for validity and reliability, which are two important measures that help ascertain whether the instrument used for data collection fulfilled important measurement criteria (Heale & Twycross, 2015). According to Heale and Twycross (2015, p. 66), Validity is defined as "…the extent to which a concept is accurately measured in a quantitative study." Reliability has also been defined as "…the accuracy of an instrument. In other words, the extent to which a research instrument consistently has the same results if used in the same situation on repeated occasions" (Heale

& Twycross, 2015, p. 66). Validity and reliability are, therefore, concerned with testing an instrument's quality and efficacy to measure the constructs it proposes to measure. In quantitative studies such as this, it is non-negotiable to check for reliability and validity; researchers are required to assess these two elements, and this was adhered to in this study. The study measures both the convergent and the discriminant validity which are the requirement for establishing construct validity (Campbell and Fiske, 1959).

According to Henseler, Ringle and Sarstedt (2015) convergent validity is established when items in a particular measure converge to represent the underlying construct. Convergent validity is established when the indicators explain 50% or more variance in the latent unobserved construct (Reverte et al., 2016). In other words, convergent validity measurement using Fornell-Lacker criterion requires the Average Variance Extracted (AVE) greater than 0.5 (Cheung and Wang, 2017). This means that to establish convergent validity statistically, AVE statistic is calculated based on the factor loadings and a latent unobserved construct having AVE value of 0.50 or higher (Fornell and Lacker, 1981).

The convergent validity of the study was tested with Average Variance Extracted and Composite Reliability. The AVE of the items of the various constructs of the study were assessed and were; Psychological Behavioural Elements = 0.501 with Composite Reliability of 0.963, Social Behavioural Elements = 0.584 with Composite Reliability of 0.969, Personal Behavioural Elements = 0.637 with Composite Reliability of 0.976 and the independent variable Adoption = 0.853 with Composite Reliability value = 0.974 (Table 5.2). The constructs convergent validity was considered substantial as the AVE values were greater than 0.5 and the composite reliability values were greater than 0.70. The items of the study are therefore valid tools in measuring Ghanaian farmers agricultural technology adoption behaviour (Table 5.2). The next quality measurement is the discriminant validity.

The discriminant validity is established to ascertain the distinctiveness of the constructs in the study (Henseler, Ringle and Sarstedt, 2015). Discriminant validity then shows the degree to which measures of different concepts are different. Fornell-Lacker criterion for discriminant validity requires the Average Variance Extracted (AVE) of both constructs greater than square correlation between the two constructs significantly less than unity (Cheung and Wang, 2017).

The discriminant validity of the study was tested with Fornell-Lacker criterion and results are presented in Table 5.3. The Fornell-Lacker criterion requires that the square root of AVE of a particular construct shall be greater than the correlation of that construct with other constructs in the study. In this study, the square root of the Average Variance Extracted for the construct AD = Adoption is greater than the correlation between the construct and the other constructs (PBE = Psychological, PEBE = Personal and SBE = Social Behavioural Elements) i.e, AD = 0.924 > its correlation with PBE = 0.761, PEBE = 0.745, and SBE = 0.711. Also, the square root of AVE for PBE = 0.837 > its correlation with PEBE = 0.762, SBE = 0.711, and AD = 0.761. Further, square root of AVE for PEBE = 0.858 > its correlation with SBE = 0.751, PBE = 0.762, AD = 0.745. Finally, square root of AVE for SBE = 0.771 > its correlations with PEBE = 0.751, PBE = 0.722, and AD = 0.711. The discriminant validity as per Fornell-Lacker criterion is established. The constructs of the study are therefore valid tools in measuring Ghanaian farmers agricultural technology adoption behaviour.

Table 5 2: Construct reliability and validity

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
AD	0.954	0.974	0.972	0.853
PBE	0.967	0.963	0.937	0.701
PEBE	0.843	0.976	0.952	0.737
SBE	0.948	0.969	0.954	0.594

Table 5 3: Discriminant validity - Fornell-Lacker Criterion

	AD	PBE	PEBE	SBE
AD	**0.924**			

PBE	0.761	**0.837**		
PEBE	0.745	0.762	**0.858**	
SBE	0.711	0.722	0.751	**0.771**

De Vellis (2003) defines reliability analysis as a method for testing the precision of a scale used to measure some phenomenon. One of the most popular ways to measure internal consistency is with Cronbach's alpha. Therefore, the reliability of the study instrument was tested with Cronbach's alpha (α). The 65 items of the questionnaire were assessed with a total Cronbach's alpha (α)" of 0.967 (0.961 - 0.972) (Table 5.4). The Cronbach's alpha for the various domain was; Psychological = 0.903 (0.886 -0.919), Social = 0.948 (0.939 - 0.957), Personal = 0.843 (0.815 - 0.868), Adoption = 0.961 (0.954-0.968). The Item's internal consistency was considered substantial as an alpha ≥0.70 was recorded in all 8-Items and the overall domain, which is considered desirable according to Snoek, Skovlund and Pouwer (2007). A questionnaire is, therefore, a reliable tool for measuring farmers' agricultural technology adoption behaviour in the Ghanaian setting.

Table 5 4: Mean scores, standard deviation and Cronbach's alpha for consumer behaviour

Constructs/dimensions	Item No	Cronbach's alpha
Psychological Behaviour Elements	19	0.967

Perceived Usefulness	11	0.822
Perceived Ease of Use	8	0.853
Social Behaviour Elements	16	0.948
Peer Influence	8	0.963
Superior Influence	8	0.927
Personal Behaviour Elements	24	0.843
Altitude	8	0.880
Self-Efficacy	8	0.894
Complexity	8	0.411
Adoption	6	0.954
All Items	65	0.967

5.7.1 Outer loadings

Vinzi, Chin, Henseler, and Wang (2010) state that factor loadings indicate an item's degree of representation of the underlying construct. Factor loadings greater than 0.70 are typically advised. All of the study's items, as shown in Table 5.5 below, have factor loadings greater than 0.70, meaning they all satisfy the requirements for a measuring model that is deemed appropriate.

Table 5 5: Outer loadings

	AD	PBE	PEBE	SBE
AD1	**0.949**			
AD2	**0.930**			
AD3	**0.942**			

AD4	0.970			
AD5	0.758			
AD6	0.974			
PBE1		0.791		
PBE10		0.757		
PBE12		0.861		
PBE13		0.849		
PBE14		0.846		
PBE15		0.874		
PBE11		0.745		
PBE16		0.727		
PBE17		0.760		
PBE19		0.897		
PBE18		0.800		
PBE2		0.753		
PBE3		0.970		
PBE4		0.727		
PBE5		0.905		
PBE6		0.740		
PBE7		0.736		
PBE8		0.765		
PBE9		0.729		
PEBE1			0.864	
PEBE10			0.915	
PEBE11			0.907	
PEBE12			0.873	
PEBE13			0.841	
PEBE14			0.906	
PEBE15			0.913	
PEBE17			0.789	
PEBE18			0.749	
PEBE19			0.818	
PEBE16			0.846	
PEBE2			0.905	
PEBE8			0.877	
PEBE20			0.713	
PEBE21			0.982	
PEBE22			0.900	
PEBE24			0.787	
PEBE23			0.925	
PEBE3			0.883	
PEBE4			0.928	
PEBE5			0.794	
PEBE6			0.927	
PEBE7			0.944	
PEBE9			0.931	
SBE1				0.895
SBE10				0.876
SBE11				0.965
SBE12				0.871
SBE13				0.819
SBE14				0.738
SBE15				0.963
SBE2				0.855
SBE3				0.852
SBE4				0.917
SBE5				0.767
SBE6				0.796
SBE8				0.846
SBE7				0.898
SBE16				0.833
SBE9				0.782

5.8 DATA ANALYSIS

A quantitative approach was used to analyse the data gathered from respondents. The data were analysed using the PLS-SEM method of structural equation modelling (SEM) and the Statistical Package for Social Sciences (SPSS) version 21. The descriptive analysis of the data, which used frequency tables to present the socio-demographic data, made up the first stage of the analysis. Additionally, the reliability analysis findings, which looked at farmers' psychological, social, and personal behavioural components, were presented using descriptive statistics. In the analysis of data, path analysis was used to measure the structural model and test for the hypothesised relationships. The Goodness of Fit Indices for the model validation and the SEM analysis was used to establish the relationship between the constructs and their indicators and among the latent variables. Exploratory factor analysis was carried out to establish the quality of the measuring items. The SEM suite includes various tools for analysing variables and determining how they relate to research objectives. For example, in order to reach a certain goal, researchers might model the link between one or more independent and dependent variables using the analysis, which triangulates variables for a deeper inference of measured variables (Tarka, 2018; Hoyle, 2012).

5.9 CHAPTER SUMMARY

In this chapter, the research methodology was covered. First, this chapter discussed the philosophical underpinnings of the research, which utilised the positivist school of thought and its quantitative technique. Next was a discussion of exploratory, descriptive, and causal research designs. This study's descriptor-explanatory methodology combined the descriptive and causal research designs. A profile of the study's participants was made in accordance with the design. It was also addressed how samples were used to choose responders. The sample size for the study was established using Cochran's method from 1977. The study then used the survey data collection approach to collect data after developing a questionnaire adapted from the adoption literature. The method of data analysis and the ethical justifications for this investigation was then explained. Overall, this chapter sheds light on the study's methodology and explains the researcher's many decisions about gathering, analysing, and interpreting data. The subsequent chapter presents the analysis of the data collected for the study and discussions of the findings.

CHAPTER SIX

DATA ANALYSIS AND DISCUSSION OF FINDINGS

6.1 INTRODUCTION

The results from the analysis of the data that was gathered are presented in detail in this chapter of the study. Results were based on the questionnaires used to gather data from smallholder commercial farmers in Ghana about consumer behaviour perspective of adoption of agricultural technology. Frequency and a percentage table for the demographic variables, such as age, gender, ethnicity, education, income, marital status, number of dependents, religion, farmer location and years of farming, are used to begin the analysis. Descriptive statistics (mean and standard deviation) were also employed to describe the variables and their dimensions per the responses provided by the participants. Since the variables were measured on a 5-point Likert scale (1= Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree), the study developed a scoring system for ease of use and understanding of results (refer to Table 1 in Appendix I). The PLS-SEM analysis, which involves evaluating the measurement and structural model, follows this section for hypothetical tests. The measuring model establishes the constructs' validity and reliability. The structural model determines the hypothesised relationships' relevance. The study assessed the relationship between psychological, social and personal factors and farmers' willingness to adopt agricultural technology.

The chapter also involves a discussion of the findings, which provides a thorough explanation of the findings and links them to the relevant literature. Furthermore, it describes how the findings affect theory and practice in marketing. Finally, the section also responds to the research objectives. In addition, the analysis is presented and discussed according to the research objectives and questions.

6.2 SOCIO-DEMOGRAPHIC CHARACTERISTICS OF PARTICIPANTS

This section of the chapter describes the socio-demographic attributes of the participants covered in the study. Even though these findings may not have any direct bearing on the study's findings, it is a basic requirement in research and clarifies the calibre of participants in the study. In this regard, this information gives an insight into the Ghanaian smallholder commercial farmer, particularly in the Volta Region of Ghana. The information, however, can be used in subsequent analysis to examine the impact of these variables or their connections with the study, relevant for decision-making. Results are presented in Table 6. 1.

Table 6. 1: Socio-Demography Characteristics of Participants

Variable	Frequency	Percent (%)
Age		
18 to 24	16	5.61
25 to 34	82	28.77
35 to 54	85	29.82
55 and above	86	30.18
Prefer not to answer	16	5.61
Gender		
Male	158	55.44
Female	123	43.16
Prefer not to say	4	1.40
Level of education		
No Education	47	16.49
Basic Education (Primary and Junior Secondary Education)	123	43.16
Secondary Education (Senior Secondary Education)	72	25.26
Tertiary Education (University, Polytechnic, etc.)	42	14.74
Prefer not to say	1	0.35
Annual income from rice farming (GHC)		
Less than 5,000	42	14.74
5,000 to 10,000	62	21.75
10,000 to 20,000	111	38.95
20,000 and above	58	20.35

Prefer not to say	12	4.21
Are you Married?		
Yes	238	83.51
No	42	14.74
Prefer not to say	5	1.75
Number of children		
None	20	7.02
1	46	16.14
2 to 4	146	51.23
5 to 7	60	21.05
8 and above	13	4.56
Religion		
Christian	159	55.79
Islamic	13	4.56
African Traditional	59	20.70
Other	41	14.39
Prefer not to say	13	4.56
Location		
Volta North	100	35.09
Central Volta	61	21.40
Volta South	92	32.28
Prefer not to answer	32	11.23
Ethnicity		
Akan	7	2.46
Ewe	250	87.72
Ga-Dangme	3	1.05
Guan	1	0.35
Mole-Dagbani	19	6.67
Other	5	1.75
Number of years farming rice		
1 to 2 years	21	7.37
3 to 5 years	115	40.35

6 to 10 years	63	22.11
11 to 15 years	38	13.33
More than 15 years	33	11.58
Prefer not to say	15	5.26

Overall, a total of 285 participants were recruited for the study. Those within the age range 55 and above had the highest proportion of 30.18% (86), followed by those within the age range 35-54 years, 29.82% (85) and 25-34 at 28.77% (82). The least were those 18 - 24 years, 5.61% (16). It indicates that small-scale farmers in the region covered in the study are evenly distributed among the ages of 25 - 34 years, 35 - 54 years and above 54 years. Both young and ageing smallholder commercial farmers constitute the participants in the study. Regarding the level of education, the majority of the participants indicated to have attained basic education (123, 43.16%). About 25.26% attained secondary education, whiles a little above 14% have qualifications as tertiary (university, polytechnics etc.) graduates. This shows that most smallholder commercial farmers operating in the region are not highly educated. The annual income of the participants from their rice farms is also indicated to be between GH¢10,000 - 20,000 mostly (38.95%). Respectively, 21.75% and 20.35% of the participants also earned between GH¢5,000 - 10,000 and above GH¢20,000 as annual incomes from rice farming. Results further show that 83.51% of the participants (smallholder commercial farmers) were married.

Also, most (51.23%) of the farmers indicated having between 2 and 4 children. These infer that the farmers have dependants and people to take responsibility for. It is further observed that participants were mostly Christians (55.79%). With the study dividing the region into 3 clusters for data collection, smallholder commercial farmers from each cluster are well represented. The northern cluster constituted 35.09%, the southern (32.28%) and the central cluster 21.40%. The Volta region is Ewe-dominated, resulting in 87% of the participants being Ewes. Most farmers were engaged in rice farming for about 3 - 5 years (40.35%). At large, the farmers have been engaged in rice farming for some time, roughly 3 years and more.

6.3 PSYCHOLOGICAL BEHAVIOURAL ELEMENTS

In this section of the chapter, the study explains the farmers' psychological behaviour based on perceived usefulness and perceived ease of use. These elements utilised as dimensions of psychological behaviour were measured in line with the use of agricultural technology. Psychological factors influence the attitude and intention of the consumer according to the consumer behaviour theory, hence considered by the study to examine how it can affect technology adoption among smallholder commercial rice farmers. Therefore, these two dimensions define the psychological behaviour of the farmer. Results presented in Table 6.2 and Table 6.3 describes responses from the survey with regard to perceived usefulness and perceived ease of use. The discussion of the study's empirical findings on the influence of the psychological behavioural elements is also presented immediately after the presentation of the analysis in this section.

6.3.1 Perceived Usefulness

Table 6. 2: Descriptive Statistics on Perceived Usefulness

Items	Mean	SD

Using yield enhancing agricultural technology helps me increase productivity	4.24	0.626
Using yield enhancing agricultural technology helps me be effective at farming	4.34	0.712
Using yield enhancing agricultural technology helps me save time	4.02	0.503
Using yield enhancing agricultural technology helps me work more quickly	4.12	0.581
Using yield enhancing agricultural technology helps me accomplish more work	4.10	0.628
Using yield enhancing agricultural technology helps me increase the quality of my work	3.98	0.534
Using yield enhancing agricultural technology helps me address my farming needs	4.13	0.812
Using yield enhancing agricultural technology helps me have control over my work	4.21	0.615
My job will be difficult without using yield enhancing agricultural technology	3.93	0.622
With yield enhancing agricultural technology, my jobs are made easier	4.11	0.734
The yield enhancing agricultural technologies I used were as useful as the ones I use today	2.12	0.633
Overall Perceived usefulness	4.11	0.435

The results indicated that participants agreed to 10 of the 11- items used in measuring perceived usefulness. In detail, there are good levels of agreement that the use of yield enhancing agricultural technology can help them increase productivity (Mean = 4.24, SD = 0.625) and effective farming (Mean = 4.34, SD = 0.712). The use of yield enhancing agricultural technology was also perceived to have helped participants work more quickly (Mean = 4.12, SD = 0.581) on their farms. Moreover, yield enhancing agricultural technology helps participants control their work (Mean = 4.21, SD = 0.615). Overall, participants agreed with the perceived usefulness of the use of agricultural technology in improving and increasing their productivity (Mean = 4.11, SD = 0.435). Smallholder commercial rice farmers, therefore, perceived that using agricultural technology is very useful to their farming activities. Looking at the present and past experiences of the farmers, the results indicate that current agricultural technologies employed are more useful than past farming innovations (Mean = 2.12, SD = 0.633).

Perceived usefulness (PU) is linked to the understanding and insight derived from the consumer psychological behaviour and the Technology Acceptance Model (TAM), which in itself derived from the psychological Theory of Reasoned Action (TRA) and Theory of Planned Behaviour (TPB). When consumers find new technologies for their functional needs, their willingness to adopt them increases. The current study revealed that PU positively influences farmers' adoption of agricultural technology. Farmers highly perceive that agricultural technologies deployed in their farming activities are relevant to their functional needs.

The positive relationship between PU and ATA is supported by empirical studies (Obiero et al., 2019; Kamble et al., 2019; Tavitiyaman et al., 2022). In a study conducted by Caffaro et al. (2020), the adoption of Smart Farming Technologies (SFT) is affected positively by PU. With regard to these findings, this research contends that if smallholder commercial farmers are not made aware of the potential advantages the adoption of agricultural technology can have on their operations, particularly their output and harvest, there cannot be technological adaptation. Wang et al. (2021) another study also confirmed that farmers were willing to adopt new practices and technology if they perceived that the new technology could enhance their yield. Farmers are willing to embrace agricultural technology once they are convinced of its utility and benefits in the application. The greater the perceived usefulness of a technological innovation, the easier it is to stimulate adoption intentions amongst farmers. It is worth mentioning that the positive relationship between the variables does not only induce an increase in adoption when perceived usefulness is high. It also cautions that if technological innovations in agriculture are perceived as useless and unable to meet the functional needs of the farmer, the likelihood of adoption reduces.

6.3.2 Perceived Ease of Use

Table 6. 3: Descriptive Statistics of Perceived Ease of Use

Items	Mean	SD
Learning to use yield enhancing agricultural technology was easy for me	4.02	0.884
I found it easy to apply instructions on yield enhancing agricultural technology	3.98	0.849
I found yield enhancing agricultural technology instructions clear and understandable	3.84	0.825
I found yield enhancing agriculture technology easy to use	3.89	1.042
The steps involved in applying yield enhancing agricultural technology are easy to remember	3.61	0.818
It is easy to become skilful at using yield enhancing agricultural technology	3.47	0.973
I found yield enhancing agricultural technology flexible to use	3.70	0.044
The yield enhancing agricultural technologies I used in the past were as easy to use as the ones I use today	2.77	1.216
Overall Perceived Ease of Use	3.79	0.652

The results indicated that participants generally have high levels of agreement with the items measuring the perceived ease of use of agricultural technology. Specifically, participants disclosed that learning to use yield enhancing agricultural technology was easy for them (Mean = 4.02, SD = 0.884). Participants also indicated that they found it easy to apply instructions on yield enhancing agricultural technology (Mean = 3.98, SD = 0.849). Yield enhancing agricultural technology instructions are clear and understandable (Mean = 3.84, SD = 0.825), as also agreed by the participants. Overall, participants agreed with the perceived ease of use in the use of agricultural technology in improving and increasing their productivity (Mean = 3.79, SD = 0.652). The smallholder commercial rice farmer largely declares or is perceived to have an ease with using agricultural technology for their farming activities. Also, the smallholder commercial rice farmers perceived the present agricultural technologies to be easier to use compared to the past innovations employed (Mean = 2.77, SD = 1.216).

From the Technology Acceptance Model (TAM), the second psychological element considered relevant in determining smallholder commercial farmers' behaviour towards technology acceptance is Perceived ease of use (PEOU). PEOU can persuade people to adopt a positive mindset, which may lead to a positive intention to utilize a specific technology (Wang et al., 2012). Farmers are most likely to oppose technological improvements because they do not comprehend how technology works and how it can be used (Barham et al., 2014). The impression of smallholder farmers regarding how simple or complex a new technology can may impact the technology's adoption rate (Takahashi et al., 2020). PEOU is instrumental in changing the attitude of smallholder farmers toward technology adoption. This research shows a high level of ease of use of technology among farmers. Smallholder rice farmers perceive that the yield enhancing technological tools and equipment they deploy in farming activities are easy to use, with less difficulty to use. The degree to which a new technology is perceived as being easy to use, handle and maintain is vital to adoption intentions. It is not surprising that perceived ease of use in this study is found to have a positive influence on ATA. The high degree of ease in using agricultural technology by smallholder farmers increases their willingness to adopt. Nonetheless, it is informed further that should farmers face difficulty using technological equipment, they are less likely to adopt or apply it.

Consistent with the findings of this study, Kapoor et al. (2014) and Clohessy et al. (2019) also found that perceived ease of use intensifies adoption intentions. Farmers become aware of the fact that adopting and using a technology might result in greater benefits and less stress when they believe it to be easy to use. A favourable attitude and positive intentions to adopt agricultural technology emerge from the notion that the farmer sees the technology as easy to use. On the other hand, the farmer develops a negative attitude towards the technology when it is perceived as difficult to operate.

6.4 SOCIAL BEHAVIOURAL ELEMENTS

Social behavioural elements used in this study include two major dimensions thought to have socially influenced the behaviour of individuals. These elements are peer influence and superior influence. In addition, the social behavioural elements deal with the connectivity of farmers with groups that can influence the norms towards change in behaviour. Results on the social behavioural elements are presented in Table 6.4 and Table 6.5. As well, the section presents the discussion of the study's empirical findings on the influence of the social behavioural elements after the presentation of the analysis.

6.4.1 Peer influence

Table 6. 4: Descriptive Statistics on Peer Influence

Items	Mean	SD

My friends think I should use yield enhancing agricultural technology	3.70	0.888
My relatives would want me to use yield enhancing agricultural technology	3.86	1.174
My colleague farmers think I should apply yield enhancing agricultural technology	3.87	1.128
My neighbours would want me to use yield enhancing agricultural technology	3.67	0.854
I feel under peer pressure to use yield enhancing agricultural technology	3.32	0.800
I use yield enhancing agricultural technology because other farmers do the same	3.86	0.955
My family approves my usage of yield enhancing agricultural technology	3.64	0.978
The influence of my peers to use yield enhancing agricultural technology was as effective as it is today	3.64	0.967
Overall Peer Influence	3.70	0.870

It is observed that participants generally agree with the influence of peers in the usage of yield enhancement agricultural technology. It is accepted among the farmers that friends (Mean = 3.70, SD = 0.888), relatives (Mean = 3.86, SD = 1.174) and colleague farmers (Mean = 3.87, SD = 1.128) were of the view that yield enhancing agricultural technology be used. On moderate levels, participants feel pressured by their peers to use agricultural technology (Mean = 3.32, SD = 0.80). Overall, participants agreed that peer influence is a factor in using agricultural technology to improve and increase their productivity (Mean = 3.70, SD = 0.870). The results also show that friends, family, and fellow farmers had an impact on whether yield enhancing agricultural technology was used in both the past and the present (Mean = 3.64, SD = 0.967).

The influence of peers is one of the dimensions of social factors considered to have an impact on technology adoption. Consumers are prone to taking decisions based on recommendations, opinions and advice from others with similar experiences. Therefore, the willingness to adopt a new technology can be predicted by peer influence, a significant social element. Testing this claim, this study revealed a significant positive effect of peer influence on smallholder farmers' adoption of agricultural technology. Smallholder farmers are influenced by their peers to take advantage of the available technology in their farming activities.

Few studies have substantiated the relationship between technology adoption and peer influence. A few of the studies which predicted the influence of peers on the adoption of technology amongst farmers did not indicate the direction of the relationship. In a study, Smith et al. (2007) supported that through word-of-mouth testimonies, peers such as close families, colleague farmers and friends provide advice and their opinions to farmers in the adoption of farming practices and technology. Interactions between farmers and their peers change their behaviours, resulting in technology adoption and use. Picking from the decomposed theory of planned behaviour (DTPB), farmers have normative beliefs and trust in their peers. They, therefore, take recommendations and advice from them on the need to adopt agricultural technology.

6.4.2 Superior influence

Table 6. 5: Descriptive Statistics on Superior Influence

Items	Mean	SD

I see Agriculture Extension Officers as very important in my work as a rice farmer	3.59	0.966
I value the opinions of Agricultural Extension Officers	3.73	0.801
Agricultural extension officers have a great impact on the kind of yield enhancing agricultural technology I use	3.35	1.063
I use yield enhancing agricultural technology that agricultural extension officers approve of	3.26	1.053
I use yield enhancing agricultural technology because Agricultural Extension Officers think I should use	3.45	1.001
Agricultural Extension Officers would want me to use yield enhancing agricultural technology	3.55	0.819
I usually do what Agriculture Extension Officers expect me to do	3.47	0.894
The availability and guidance of Agricultural Extension Officers to use yield enhancing agricultural technology was as accessible as it is today	1.98	0.530
Overall Superior Influence	3.48	0.737

On high levels of agreement among participants, agricultural extension officers are perceived as important in the work of farmers (Mean = 3.59, SD = 0.966). Participants also indicated that they value the opinion of the extension officers with regard to their advice and suggestions in their farming activities (Mean = 3.73, SD = 0.801) and also agreed that the extension officers always intended to want farmers to use yield enhancing agricultural technology (Mean = 3.55, SD = 0.819). On the other hand, participants moderately agree with issues such as the use of yield enhancing agricultural technology because extension officers think it should be used (Mean = 3.45, SD = 1.001). Participants further indicated that they do not fully accept that extension officers expect them to do what they wanted (Mean = 3.47, SD = 0.894). Overall, it is observed that there are moderate levels of agreement among participants with reference to superior influence (Mean = 3.48, SD = 0.737). These also indicate that smallholder rice farmers do not think the actions of extension officers highly influence them. However, they do pay attention to their recommendations and suggestions. On the other hand, the smallholder commercial rice farmers disagreed that agricultural extension officers were as accessible in the past as in the present (Mean = 1.89, SD = 0.530).

The findings of this study revealed a significant relationship between superior influence and technology adoption among farmers. However, the degree to which farmers get influenced by superiors is indicated as moderate. This is reflected in the causal-effect. Superior influence, though, had a significant positive effect. However, this effect was minimal. The relationship between superior influence and technology adoption was also empirically validated in research (Emmanuel et al., 2016; Nyarko & Kozari, 2021). Even though not directly in the agricultural sector, Crabbe et al. (2009) found that superior influence strongly predicts intention to adopt mobile technology in Ghana. Superiors exert some pressure on and delicate action on farmers to apply agricultural technology.

With this use of pressure to dictate action, farmers can be assisted through effective guidance and education on the relevance and application of technological systems. Smallholder commercial farmers often belong to professional associations and bodies that provide them with membership. By some standard practices, such associations can influence farmers to adopt technology (Yadegaridehkordi et al., 2020). The beneficial and considerable impact of superior influence on the adoption of farm-based technologies was further validated by Li et al. (2021). In smallholder farming, the views of influential superiors can persuade others to adopt attitudes and behaviours that facilitate the use of agricultural technology (Emmanuel et al., 2016; Nyarko & Kozari, 2021).

Unlike peer influence, superior influence is frequently seen as a higher type of opinion or acceptance, which gives superior influence a tiny edge over peer influence, according to Campenhout (2021). In this study, however, peer influence has a greater effect on technology adoption as compared to the superior effect. This raises questions as to why smallholder farmers rely more on the advice and recommendations of their peers than against superiors.

6.5 PERSONAL BEHAVIOURAL ELEMENTS

Another contentious issue in literature was what degree a customer's personal behaviour influences decision-making. In this regard, the personal behavioural elements were to be tested in this study. These elements include consumer attitude, consumer self-efficacy, and consumer perceived technology complexity. The responses to these elements from the perspective of participants are shown in this section of the chapter. After the presentation of the analysis, the discussion of the findings on the influence of the personal behavioural elements is also presented in this section.

6.5.1 Attitude influence

Table 6. 6: Descriptive Statistics on Attitude

Items	Mean	SD
Using yield enhancing agricultural technology is good	4.01	0.940

Using yield enhancing agricultural technology is desirable	4.02	0.945
Using yield enhancing agricultural technology is valuable	3.81	0.852
Using yield enhancing agricultural technology is ethical	4.02	1.022
Using yield enhancing agricultural technology is possible	3.73	0.570
Using yield enhancing agricultural technology is challenging	1.92	0.483
I will always use yield enhancing agricultural technology in farming	3.77	0.673
Some years ago, I felt good using yield enhancing agricultural technologies as I feel today	1.89	0.590
Overall Altitude	3.61	0.612

The results indicate that participants have agreed that the use of yield enhancing agricultural technology is good (Mean = 4.01, SD = 0.940), desirable (Mean = 4.02, SD = 0.945), and ethical (Mean = 4.02, SD = 1.022). Participants further demonstrated high levels of agreement that using yield enhancing agricultural technology is valuable (Mean = 3.81, SD = 0.852), and the use is also regarded as possible (Mean = 3.77, SD = 0.673). They also believed that using technology for their farming activities is not challenging (Mean = 1.92, SD = 0.483). Generally, the attitude among participants with reference to the use of yield enhancing agricultural technology towards improving productivity is high (Mean = 3.61, SD = 0.612). On the other hand, the participants did not feel good using agricultural technologies in the past as they feel currently (Mean = 1.89, SD = 0.590).

Attitude has been found to be an important factor in a number of previous studies to have influenced decision-making and behaviour (Cafarro & Cavallo, 2019). For example, Knierim et al. (2019), who explored the factors that influence farmers' and other stakeholders' adoption of smart farming technology (SFT) innovations, found that attitudes and perceptions of farmers affected their adoption of SFT innovations. This finding is consistent with subsequent studies such as Shang et al. (2021), Dadzie et al. (2022), Elahi et al. (2022), Cavallo et al. (2014) and Nyairo et al. (2022). The results of the present study are also in line with these previous studies.

The descriptive statistics of this study show that the smallholder commercial farmer demonstrated a high level of attitude towards the use of agricultural technology. The findings of this study agree with the literature, confirming that the attitude of the Ghanaian rice farmer has a significant positive effect on ATA. According to Verma and Sinha (2018), attitude is regarded as a strong predictor of technology behaviour, which has manifested in this study. Attitude, therefore, shapes the behavioural intention of the rice farmer to adopt agricultural technology. The positive effect, however, is a caution, indicating that should there be a decrease in farmers' attitudes, the intention to adopt the technology would decrease. Contrary to the positive effect identified in this study, Kaler and Ruston (2019) revealed a negative effect of attitude on the adoption and response to precision technology among livestock farmers. A similar phenomenon could occur in the case of rice farmers if their attitude towards technological innovations and instruments decreases.

The attitude of the farmers has determined their likeness to the yield enhancing agricultural technologies they used. This is in sync with the view of scholars like Ajzen and Fishbein (1980), who opined that attitude determines the likeness or rejection of technology. Further, many theories of technology adoption are linked to attitude formation and social psychology (Michelsen & Madlener, 2013). For instance, the Theory of Reasoned Action (TRA) by Fishbein and Ajzen (1967) explained how attitudes and subjective norms influenced behavioural intentions and actual behaviour. In the Theory of Planned Behaviour (TPB), Ajzen (1991) found that three factors influenced behavioural intentions, among which was attitude. The Decomposed Theory of Planned Behaviour (DTPB) by Taylor and Todd (1995) also explained three influences on an individual's intentions to perform a certain behaviour and included the attitude towards the behaviour. So, the finding of this study that the attitude of farmers influenced their adoption of agricultural technology is confirmed by adoption theories and other studies.

Since the Attitude of farmers is such an important factor in adopting agricultural technologies, this element should be given priority. Therefore, any initiative or campaign geared towards increasing the adoption of agricultural technologies needs to emphasise how to establish positive attitudes in farmers' minds.

6.5.2 Self-Efficacy

Table 6. 7: Descriptive Statistics on Self-Efficacy

Items	Mean	SD
I feel confident I can use yield enhancing agricultural technology	3.71	0.824
I feel confident I can learn to use yield enhancing agricultural technology	3.93	0.868
I feel confident that when I use yield enhancing agricultural technology, I can increase my yield	3.81	0.796
I feel confident that I can apply different yield enhancing technologies to increase my produce	3.71	0.928
I feel confident that I can expand my farm with the help of yield enhancing agricultural technologies	3.88	1.053
I feel confident that I can find new ways to integrate yield enhancing technologies in my farming methods	3.46	0.775
I have the knowledge and ability to use yield enhancing agricultural technology	3.73	0.864
I felt confident to use yield enhancing agricultural technologies in the past, as I feel today	1.78	0.586
Overall Self-Efficacy	3.75	0.640

With regards to responses on the self-efficacy of farmers in the use of yield enhancing agricultural technology, it is observed that there was agreement among participants on most of the items in the Table. Participants were confident that they could use yield enhancing agricultural technology (Mean = 3.71, SD = 0.824) and the confidence extends to learning such technological applications (Mean = 3.93, SD = 0.868). The high confidence level also shows that using yield enhancing agricultural technology can increase yield (Mean = 3.81, SD = 0.796) and expand farm sizes (Mean = 3.88, SD = 1.053). Overall, it is shown that the self-efficacy of farmers in using yield enhancing agricultural technology is high (Mean = 3.75, SD = 0.640). However, the results also indicate that participants did not feel confident in the past to use agricultural technologies as they feel currently (Mean = 1.78, SD = 0.586).

The second personal factor in the adoption of behavioural elements hypothesised in this study to influence smallholder farmer adoption of agricultural technology is self-efficacy. The results of the study indicate that self-efficacy is one of the important factors influencing smallholder commercial farmers' adoption of agricultural technology positively. The smallholder farmers investigated in the study show a high level of confidence in using yield enhancing agricultural technology, increasing agricultural yield through yield enhancing agricultural technology, and expanding their farms with the help of yield enhancing agricultural technology. The farmers believe in their ability to use agricultural technology to enhance yield (Venkatesh & Bala, 2008). After evaluating and assessing themselves according to this study, smallholder farmers felt they are competent to put agricultural technology to use in their farming activities. Farmers demonstrated they could use agricultural technology.

The finding of this study concurs with many recent works on factors influencing ATA by smallholder farmers. Igbaria (1995), Zobiede et al. (2021), and Wuepper and Lybbert (2017) provide that self-efficacy positively predicts the acceptance of technology innovations and systems. The concept of self-efficacy was found to be significantly high (Zarafshani et al., 2020; Alalwan et al., 2015; Tarhini et al., 2015). The high self-efficacy of the smallholder farmers in Ghana is the basis for their adoption of agricultural technology. Other scholars (Kavandi & Jaana, 2020; Wu & Mweemba, 2010) also support the position of this study. It is, however, emphasised that self-efficacy in influencing technology adoption can be affected by other factors such as orientation, education and training (Adamovic et al., 2022; Atabek, 2020). Therefore, it would be interesting to investigate the mediation role of these factors (education, training and orientation) in the relationship between self-efficacy and technology adoption.

Farmers with high self-efficacy will have a greater sense of awareness, belief and confidence in their capabilities, and this changes their behaviour and result in technology adoption. Theoretically, the link between self-efficacy and agricultural technology acceptance supports social-cognitive theory (SCT). The personal factors as a component embedded in the SCT suggest that beliefs and recognition of cognitive competencies play a role in decision-making and change an individual's behaviour towards the desired outcome.

6.5.3 Complexity

Table 6.8: Descriptive Statistics on Complexity

Items	Mean	SD

I feel that it takes a lot of effort to become skilful at using yield enhancing agricultural technology	2.71	0.877
Using yield enhancing agricultural technology is frustrating	1.98	0.041
Applying yield enhancing agricultural technology requires mental effort	2.02	0.644
I found the application of yield enhancing agricultural technology confusing	2.08	0.776
I found yield enhancing agricultural technology instructions cumbersome	2.03	0.655
I found yield enhancing agricultural technology to be rigid and inflexible	2.18	0.705
Overall, I feel that yield enhancing agricultural technology is difficult to use	2.81	1.085
In the past, the yield enhancing agricultural technologies was as difficult to use as they are today	1.95	0.033
Overall Complexity	2.27	0.337

In examining the personal behaviour of farmers, the study also considered how complex agricultural technology is to be used or applied. It is shown that items measuring complexity scored low. Moderately, participants indicated they do not feel that it takes a lot of effort to become skilful using agricultural technology (Mean = 2.71, SD = 0.877). They also disagree that using yield enhancing agricultural technology is frustrating (Mean = 1.98, SD = 0.041). Results further show that from the participants' perspective, using agricultural technology is not confusing (Mean = 2.08, SD = 0.776) and does not require effort in the application (Mean = 2.08, SD = 0.644). The instructions in using agricultural technology are also not regarded as cumbersome (Mean = 2.03, SD = 0.655) and are not found rigid and inflexible (Mean = 2.18, SD = 0.705). Overall, participants do not think using agricultural technology is complex (Mean = 2.27, SD = 0.337). The participants' experience shows that past and present agricultural technologies were not complex (Mean = 1.95, SD = 0.033).

Complexity is the last personal factor in the adoption of behavioural elements hypothesised in this study to influence smallholder farmer adoption of agricultural technology. Complexity forms a major component of the Diffusion of Innovation (DOI) theory and identifies with the degree of difficulty consumers encounter regarding technology use. In agreement with the findings of this study, the relationship between complexity and technology adoption has been generally regarded as inverse (Danso-Abbeam et al., 2020; Pathak et al., 2019, Murray et al., 2016). This assertion has been disproved in this study. This study discloses that there is low complexity attached to the use of yield enhancing agricultural technology among farmers. This low level of complexity is found to have a significant negative effect on farmers' adoption of agricultural technology. This revelation also concurs with scholars like Lambrecht et al. (2014) and Fayisa (2020), which indicate that when complexity is low, its effect on consumers' perception in their decision-making to accept new technology is positive. Farmers would prefer working with technological tools and equipment that are less complex. Manolo et al. (2022) also identified with the debate, revealing that its adoption among smallholder farmers is less likely when technology is more complex. It is important to note that the complexity of a technology depends on the system or components of the particular technology in question.

On the contrary, Marks and Thomas (2022) argued that a complex technology rather increases the likelihood of adoption because such technologies are often regarded as more effective and efficient. However, Marks and Thomas's (2022) assertion relates to medical personnel, contractors and engineers. However, farmers tend to be traditional and have a bad attitude toward sophisticated agricultural technologies. Therefore, sophisticated technology can do more harm than help to the farmer.

6.6 AGRICULTURAL TECHNOLOGY ADOPTION

With the focus of the study on how the above consumer elements described relate to or influence the adoption of agricultural technology among farmers, their willingness to adopt was measured in the study on 6-items. Based on the participants' views, these results are depicted in Table 6.9.

Table 6.9: Descriptive statistics on adoption

Items	Mean	SD
I intend to use yield enhancing agricultural technology in the future	3.83	0.815
I expect that I will use yield enhancing agricultural technology in my daily farming activities	3.99	1.041
I expect that I will use yield enhancing agricultural technology frequently	3.90	1.134
I adopt the use of yield enhancing agricultural technology	3.77	0.841
I use yield enhancing agricultural technology in my daily farming activities	3.51	0.803
I will continue to use yield enhancing agricultural technology frequently.	3.73	0.896
Overall Adoption	3.79	0.851

Participants demonstrated a high level of intention to use yield enhancing agricultural technology in the future (Mean = 3.83, SD = 0.815). The responses also show a high expectation among participants to use agricultural technology in their daily farming activities (Mean = 3.99, SD = 1.041). Furthermore, participants expect to use agricultural technology frequently (Mean = 3.90, SD = 1.134). Participants also agree that they adopt (Mean = 3.77, SD = 0.841) and use (Mean = 3.51, SD = 0.803) agricultural technology for daily farming activities. There is also the willingness among participants (farmers) to continue using agricultural technology (Mean = 3.73, SD = 0.896). Overall, there is a high level of willingness among smallholder rice farmers to adopt agricultural technology (Mean = 3.79, SD

= 0.851). In other words, the willingness to adopt agricultural technology is high among farmers.

In the literature farmers' willingness to adopt agricultural technology is widely documented. ATA offers benefits as it is demonstrated in Danso-Abbeam et al., 2017 who researched on factors influencing farmers' decision to adopt agrochemicals in Ghana. The findings revealed that smallholder farmers' adoption of agrochemicals was as a result of the perception that there are benefits associated with its use especially in instances of soil fertility and enhanced farm output. Doss (2006) discovered that farmers embraced agricultural technology since it boosts productivity and yield. The World Bank (2007) has confirmed this conclusion that ATA raises farmer income. According to recent studies, the advantages of ATA include reducing poverty and enhancing the standard of living for smallholder farmers (Arslan, Wollni, Oduol & Hughes, 2022). Additionally, research shows that farmers conduct cost and benefit analyses of ATA and evaluate benefits to determine whether those benefits will remain accessible throughout a variety of future time periods. So, there is adequate evidence to support the conclusion that rice farmers in the Weta Irrigation Scheme are willing to adopt agricultural technologies.

6.7 PSYCHOLOGICAL BEHAVIOUR ELEMENTS AND ATA

In this section of the chapter, the study aims to examine the influence of psychological elements of farmers' behaviour derived from the theory of consumer behaviour on their willingness to adopt agricultural technology. In this regard, the two dimensions of psychological behaviour (Perceived usefulness and perceived ease of use) were used as the independent variables, while adoption constituted the dependent variable. The analysis in this section seeks to test hypotheses one (H1) and two (H2) of the study, addressing research questions 1 and 2.

Table 6.10: Behaviour elements and ATA

Variables	Coefficients	Standard	p-value

			Error	
	Unstandardised	Standardised		
ATA <--- PU	0.203	0.104	0.074	0.006
ATA <--- PEOU	1.034	0.792	0.049	0.000
Measures of fit: NFI= 1.00, TLI=1.00, CFI=1.00, RMSEA=0.756, R^2=0.733				

ATA=Agricultural Technology Adoption; PU=Perceived Usefulness; PEU=Perceived ease of use

Table 6.10 depicts results that model the relationship between psychological behavioural elements of smallholder commercial rice farmers and their willingness to adopt the use of yield enhancing agricultural technology for their farming activities. It is revealed that a strong positive relationship exists between psychological behaviour elements and the willingness to adopt agricultural technology. This is supported by the correlation coefficient of 0.85 ($\sqrt{0.733}$). The coefficient of determination (R^2=0.733) also explains that about 75% of the changes in the willingness of farmers to adopt agricultural technology have been explained by the changes in their psychological behaviour. About 75% of the time, the study shows that the adoption of agricultural technology is accounted for by perceived usefulness and perceived ease of use of the technology.

Specifically, perceived usefulness (PU) agricultural technology positively influences the willingness to adopt among rice farmers (β=0.104, p=0.006). Furthermore, ATA is positively influenced by perceived ease of use (β=0.792), significant at $p<0.05$. These explain that with any change in the perceived usefulness of agricultural technology among farmers, their willingness to adopt it will either increase or decrease by 0.104. If farmers perceive that a certain agricultural technology is useful for their farming activities, they will adopt such technology to increase productivity and enhance yield. On the other hand, if the technology, as perceived by farmers, is not useful, adoption will decrease. Likewise, farmers' perception that agricultural technology can be used easily without difficulties increases their willingness to adopt it. However, if the technology is not easy to use, its adoption level among farmers will decrease. The model is also well explained in Figure 6.1. In conclusion, hypotheses H1 and H2 are rejected, and the study confirms a significant positive relationship between perceived usefulness and perceived ease of use.

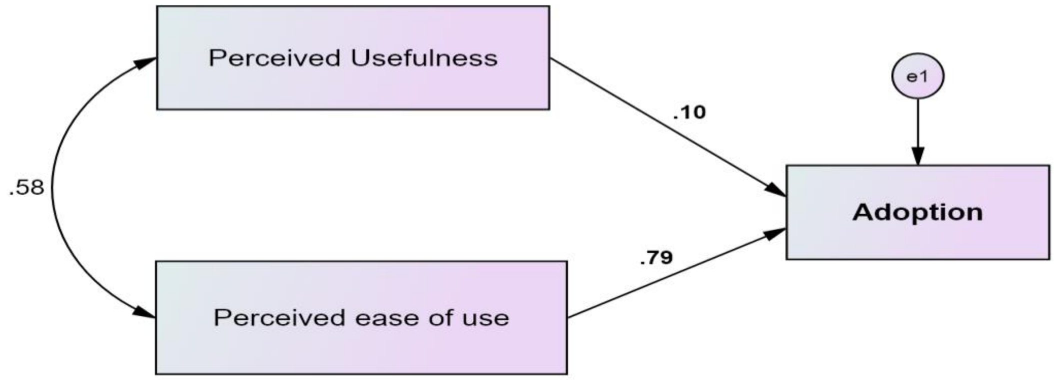


Figure 6.1: SEM between psychological elements and adoption

According to the study's hypotheses, PU and PEOU are operationalized psychological characteristics that have a significant relationship to farmers' willingness to indulge in ATA. The Technology Acceptance Model (TAM)'s adoption parts, PU and PEOU, are crucial consumer psychological behaviours. Other studies (Zhou and Abdullah, 2017; Ouko, Mukhebi, Obiero and Opondo, 2022; Victor, Nic and Xiaomeng, 2021; Kamble et al., 2019; Tavitiyaman et al., 2022; Obiero et al., 2019) have confirmed the psychological components (PU and PEOU) have a substantial positive connection. According to the results of these investigations, PU and PEOU are responsible for the ATA. Smallholder farmer if s in Ghana's perception of the usefulness and simplicity of agricultural technology are essential anchors for farmers' adoption of these technologies. The PU and PEOU are based on how each farmer perceives the agricultural technology (McDonald, Heanue, Pierce, and Horan, 2016; Verma and Sinha, 2018), and these psychological considerations influence how farmers decide whether or not to adopt agricultural technology for their farming operations (Kamrath et al., 2018; Khoza et al., 2021). Evidence from the literature shows that PU and PEOU strongly predict

ATA, which supports the validity of the conceptualization of psychological components used in this study to predict ATA.

6.8 SOCIAL BEHAVIOURAL ELEMENTS AND ATA

The nexus between the willingness of ATA among farmers and the social behaviour of farmers is ascertained in this section of the chapter. This addresses research questions 3 and 4. Theoretically, peers and people in superior positions can influence the behaviour towards using technology. This assertion is tested in the study. Results are presented in Table 6.11 and Figure 6.2

Table 6.11: Relationship between social behaviour elements and adoption

Variables	Coefficients		Standard Error	p-value
	Unstandardised	Standardised		
ATA <--- PI	0.755	0.771	0.039	0.000
ATA <--- SI	0.115	0.099	0.046	0.012
Measures of fit: NFI= 1.00, TLI=1.00, CFI=1.00, RMSEA=0.707, R^2=0.687				

ATA=Agricultural Technology Adoption; PI=Peer Influence; SI=Superior Influence

The results demonstrate that social behaviour and the willingness to adopt agricultural technology among farmers are strongly related positively (r=0.828). Results further show that the variation in social behavioural elements accounts for 68.7% of the variation in farmers' willingness to adopt agricultural technology. The influence of peers and superiors or officers in the agricultural sector, about 68.7% of the time, cause changes in technology adoption. In particular, peer influence on rice farmers causes positive changes in farmers' willingness to adopt technology (β=0.771, p=0.000). Significantly, superior influence positively affects farmers' willingness to adopt agricultural technology (β=0.099, p=0.012). However, the influence of peers on the farmers is strongly felt compared to superior influence. Rice farmers’ level of willingness to adopt agricultural technology will increase by 0.771 if there is any unit increase in influences caused by peers. Otherwise, their willingness will likely decrease by 0.771 due to any unit decline in peer influence.

An increase in superior influence by a unit will cause willingness to adopt agricultural technology by 0.099, and vice versa. Overall, the results confirm that hypotheses H3 and H4 will be rejected.

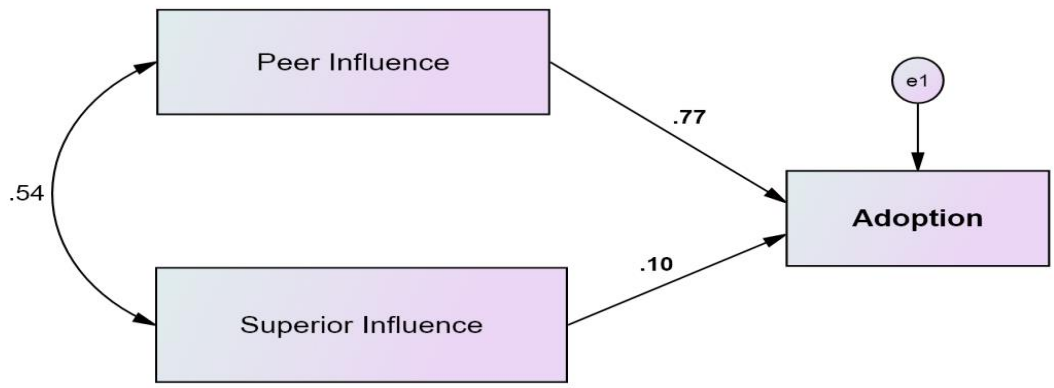


Figure 6.2: SEM between social elements and adoption

In this study, social effects such as peer and superior influences are conceptualized in order to predict ATA. Social influence is a regular occurrence in the agricultural community since it consists of people who are closely related to one another and who share similar values and opinions (Cole & Fernando, 2021). The findings of this study show a considerable positive correlation between social behaviour and willingness to accept agricultural technologies. The empirical investigations report this finding. Sampson and Perry (2019), for instance, who looked at the significance of peer effects in the adoption of natural resources, discovered that farmers' decisions to use groundwater irrigation were strongly influenced by their peers. Adnan et al.'s (2019) analysis of farmer behaviour in adopting green fertilizer technology for sustainable agriculture discovered that social factors influenced farmer decision to accept the technology. The impact of superiors' opinions was also discovered to have an impact on ATA. The adoption of mobile banking technology is influenced by social factors, according to Crabbe, Standing, Standing, and Karjaluoto's (2009) study of the factors influencing adoption and non-adoption in Ghana. According to a study of the existing literature, the Decomposed Theory of Planned Behaviour (DTPB) conceptualised subjective norms as consisting of two different types of influences: peer and superior influences (Sadaf & Gerzer, 2020; Zaman et al., 2021). According to research by Garay et al. in 2019 and Yan, Zhao, Zhang, Deng, and Zhang in 2022, subjective norms are a person's ideas about how a particular behaviour would be viewed by significant individuals in their social or professional environment. The research from the literature shows that social influence has an impact on ATA.

6.9 PERSONAL BEHAVIOURAL ELEMENTS AND ATA

The study further examined the connection between the personal behaviour of farmers in terms of attitude, self-efficacy and complexity, and the willingness to adopt agricultural technology. This relationship is modelled using the Structural Equational Modelling (SEM) shown in Table 6.12 and Figure 6.3.

Table 6.12: Relationship between personal behaviour elements and adoption

Variables	Coefficients		Standard Error	p-value
	Unstandardised	Standardised		
ATA <--- AT	0.528	0.380	0.088	0.000
ATA <--- COM	-0.196	-0.078	0.069	0.005
ATA <--- SE	0.679	0.511	0.086	0.000
Measures of fit: NFI= 1.00, TLI=1.00, CFI=1.00, RMSEA=0.791, R^2=0.822				

ATA=Agricultural Technology Adoption; AT=Attitude; SI=Self-Efficacy; COM=Complexity

The study found a strong positive relationship between ATA among farmers and their personal behaviour (r=0.91). Furthermore, the coefficient of determination (R^2=0.822) revealed that 82.2% of the changes in farmers' willingness to adopt agricultural technology are accounted for by changes in farmers' personal behavioural factors/elements. This shows that significantly, the willingness of farmers to use agricultural technology for their farming activities highly depends on personal behavioural elements.

The SEM linking the variables shows that consumer attitude significantly affects the willingness to adopt agricultural technology (β=0.380, p=0.000). This indicates that a unit change in attitude would change farmers' willingness to adopt agricultural technology by 0.380. A good, desirable, ethical and valuable attitude shown by rice farmers towards agricultural technology will increase willingness to adopt. Likewise, should farmers have a bad attitude towards yield enhancing agricultural technology, their willingness to adopt will decrease. It is also revealed that farmers' self-efficacy positively affects willingness to adopt agricultural technology, significant at a 95% confidence level (β=0.511, p=0.000). Among the personal behavioural elements, self-efficacy has the highest significant effect on adoption. This shows that whenever the self-efficacy of the farmer increases by a unit, the willingness of the farmer to adopt technology increases by 0.511, and vice versa. Moreover, complexity in using agricultural technology significantly influences adoption negatively (β=-0.078, p=0.005). The study, therefore, rejects hypotheses H5, H6 and H7. It is inferred that rice farmers' attitude and self-efficacy significantly affect their willingness to adopt agricultural technology. On the other hand, the complexity of agricultural technology has a significant negative effect on its adoption.

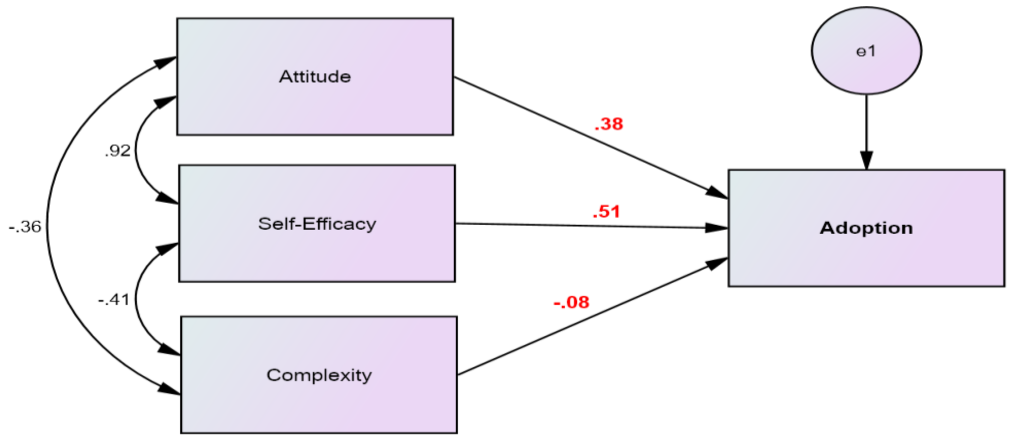


Figure 6. 3: SEM between personal elements and adoption

The findings of this investigation are supported by the literature. The study put forth the hypothesis that a farmer's readiness to accept agricultural technology is significantly influenced by personal behavioural factors. The attitude of the farmer, his or her level of self-efficacy, and the complexity of the technology are operationalized as the farmer's personal behaviour. Personal characteristics that affect customers' purchasing decisions and vary from consumer to consumer are among the factors that affect consumer behaviour (Rezaei et al., 2020). Farmers' adoption decision-making has been found to be influenced by attitude, self-efficacy, and complexity (Knierim et al., 2019; Sharifzadeh et al., 2017; Kumar et al., 2018). For instance, Dadzie et al. (2022) on the relationship between social networking and risk attitudes and its implications for smallholder cassava farmers in Ghana indicated that positive attitudes lead to positive behaviours and have an impact on ATA. According to the literature, agricultural technology innovations have failed as a result of poor attitudes (Bagheri et al., 2017). In the opinion of Venkatesh et al. (2008), self-efficacy, which is the individual's belief in his capacity to use a technology, has a substantial association with ATA (Bukchin et al., 2022). According to Wuepper et al. (2017) which examined how farmer perceived self-efficacy affected poverty and economic development, self-efficacy is scored highly among farmer attributes that affect ATA. Another factor influencing adoption of agricultural technology is technology complexity. Similar results were obtained in other agricultural studies (Manalo et al., 2022; Kumar et al., 2018). Low technology complexity is one of the criteria that predicts ATA, according to Strong, Wynn II, Lindner, and Palmer (2022) who studied the evaluation of the Internet of Things (IoT) smart agriculture adoption obstacles among Brazilian agriculturalists. The findings of this study indicated that personal traits of farmers impacted decision to embrace or reject agricultural technology and were supported by the body of existing literature (Bukchin & Kerret, 2018). In their investigation on the significance of personal factors in farmers' adoption of green technology, Bukchin et al. (2018) discovered that while individual farmer traits varied, they all had an impact on farmers' decisions to adopt agricultural technology.

6.10 CONSUMER BEHAVIOURAL ATTRIBUTES OF FARMERS AND ATA

This section of the analysis attempted to provide a comprehensive analysis of the influence of consumer behaviour on the adoption of agricultural technology. This is a more complete model that comprises the various components of the entire model, hence addressing the main research objective. The final model's detailed results are depicted in Table 6.13 and Figure 6.4.

Table 6.13: Relationship between consumer behaviour and adoption

Variables	Coefficients		Standard Error	p-value
	Unstandardised	Standardised		
ATA <--- Psychological	0.544	0.310	0.080	0.000
ATA <--- Social	0.303	0.251	0.048	0.000
ATA <--- Personal	0.946	0.421	0.103	0.000
Measures of fit: NFI=0.980, TLI=0.918, CFI=0.987, RMSEA=0.507, R^2=0.809				

Figure 6.4 explains the construct validity of each element that measures the various consumer behaviour factors. For example, perceived usefulness (PU) and perceived ease of use (PEU) have high factor-score loadings that define psychological behaviour. Peer influence (PI) and superior influence (SI) also have high factor scores loaded on social behaviour. Farmers' personal behaviour was also highly influenced by attitude (AT) and self-efficacy (SE), which recorded high factor scores. However, complexity (COM) has a low factor-score loading onto personal behaviour. Therefore, it is not surprising that, as revealed in Table 6.12, complexity was the least personal factor influencing ATA. Moreover, the 6-items measure farmers' willingness to adopt high factor scores.

The overall model shows a significant positive relationship (r=0.89) between consumer behaviour elements and the adoption of agricultural technology. The coefficient of determination (R^2=0.809) also revealed that about 81% of the variation in farmers' willingness to adopt agricultural technology is attributed to the variation in consumer behaviour elements. ATA among smallholder commercial rice farmers depends on the consumer behaviour elements. The regression coefficients explain that the psychological behaviour of farmers significantly influences ATA positively (β=0.310, p=0.000). Likewise, social behaviour has a significant positive (β=0.421, p=0.000) effect on ATA. The effect of personal behaviour is also significantly positive (β=0.421, p=0.000). Among these factors it is observed that personal behaviour has the greatest effect on adoption, followed by psychological and social behavioural elements the least.

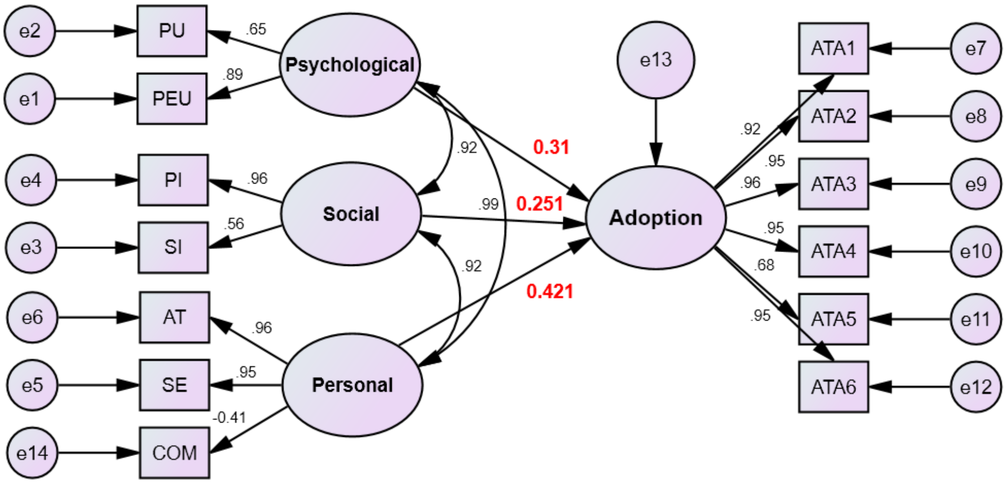


Figure 6.4: SEM between consumer behaviour and adoption

The research's conclusions are supported by the literature. It has been hypothesized that ATA is influenced by the psychological, social, and individual components of consumer behavior. The literature (Roberts, Flin, Millar, & Corradi, 2021; Gerli et al., 2022) has extensively established the considerable positive link observed between consumer behaviour factors and farmers' readiness to adopt agricultural technology. Agriculture technology is a product that farmers use as consumers. According to Bagheri, Bondori, Allahyari, and Surujlal (2021) and Ulhaq, Pham, Le, Pham, and Le (2022), agricultural technology adoption is impacted by how well it meets farmers' demands. These factors were the subject of numerous studies, each of which discovered a strong connection between them and ATA. Naberia, Gaustam, and Gupta (2015) discovered a significant association between psychological aspects and farmers' ATA in their study of the psychological traits of women in agriculture that affect adoption of low cost agricultural technology in India. Furthermore, Crabbe et al. (2009) discovered that social factors in Ghana had an impact on the adoption of mobile banking technology. In a different study, Bukchin et al. (2018) discovered that a farmer's behaviour in adopting green technology is influenced by personal factors. This study revealed a relationship between farmers' psychological, social, and personal characteristics and their willingness to accept agricultural technology.

6.11 GOODNESS OF FIT INDICES (MODEL VALIDATION)

The models are evaluated using measures of model fit, including NFI, TLI, CFI and RMSEA (Hair et al., 2010). SEM was the focus of the final stage of developing the model. The interrelationships between the variables can be assessed using SEM, which is based on the hypotheses made in the theoretical framework. Two forms of model fit measurements were employed in this study. One is the measure of absolute fit (measures). The Root Mean Square Error of Approximation (RMSEA) is the appropriate test for this. There are also incremental fit indices. They are used to see if the estimated model has a better match than an alternative baseline model, where the number of items in each model may differ. NFI, TLI, and CFI were used. The normal fit index (NFI) is a metric for model fit that should have a minimum score of 0.9 (Hair et al., 1998), as well as the Tucker-Lewis Index (TLI) and Comparative Fit Index (CFI). Furthermore, Hair, Sarstedt, Ringle and Mena (2012) proposed that, in the case of large samples, the root mean square error of approximation (RMSEA) be used instead of the chi-square test to measure the goodness of fit. RMSEA cut-off is less than or equal to 0.80.

Sixty-five items make up the constructs in this study. The fit indices NFI, TLI, and CFI for each of the models were all high values. TLI and CFI both exceed the minimum level, whereas NFI comes close to it. The findings for model fit met the minimal acceptable level of 0.9. The RMSEA recorded for the respective four models was below the suggested cut-off (0.80), indicating that the models' fit was at an acceptable value, satisfying the required basic condition. The entire model, therefore, concluded to be fit and valid for predictions and decision-making.

Table 6.14: Goodness of Fit Indices

Measures-of-fit Indices	Criteria (Cut-off value)	Model1	Model 2	Model 3	Model 4
RMSEA	≤ 0.80	0.756	0.707	0.791	0.507
NFI	>0.9	1.00	1.00	1.00	0.980
TLI	>0.9	1.00	1.00	1.00	0.918
CFI	>0.9	1.00	1.00	1.00	0.987

RMSEA: Root Mean Square Error of Approximation; NFI: Normed Fit Index; CFI= Comparative Fit Index

6.12 CHAPTER SUMMARY

This chapter presents the data analysis and comments on the findings. The study's data analysis reveals a significant positive association between consumer behavioural factors and commercial smallholder farmers' willingness to adopt agricultural technology. It has been established that the psychological, social, and personal traits of farmers serve as essential pillars for accelerating the adoption of agricultural technology and raising farmer output. According to the psychological consumer behaviour component, smallholder commercial farmers readily adopt agricultural technology as they perceive it to be useful to their farming operations and easy to use. In the social sphere, farmers' willingness to use agricultural technology is more influenced by their peer's families, friends, and fellow farmers. The influence of superiors is also important. Agriculture engineers, program administrators, scheme managers and agricultural extension officers all have a significant effect. Furthermore, three constructs were used to evaluate the personal attributes of farmers: attitude, self-efficacy, and complexity. The most important factor influencing farmers' willingness to use agricultural technology appeared as self-efficacy. Adopting existing agricultural technology will be considerably aided by the farmer confidence generated via education and training. The study indicates that Ghana's small-scale commercial rice producers intended to use agricultural technology in their farming practices. The final chapter gives the conclusions and recommendations of this research work.

CHAPTER SEVEN

CONCLUSIONS AND RECOMMENDATIONS

7.1 INTRODUCTION

This chapter of the study provides conclusions and makes recommendations on the study based on the findings derived from the analysis. The recommendations cover practice applications and areas for future research. The limitation of the study is also included in this chapter of the study.

7.2 SUMMARY OF THE RESEARCH

This research work was presented in seven chapters. Chapter One gives the background of the study in various sections that include the introduction, the state of the agricultural sector in Ghana, some incentives to support the agricultural sector in Ghana, the state of the smallholder commercial farming in Ghana, problem background, problem statement, aims of the study, research questions, the hypotheses of the study, objectives of the study, the significance of the study, the scope of the study, the ethical considerations, organisation of the thesis and the chapter summary.

Chapter Two presented the literature review on ATA by smallholder commercial farmers. The chapter was structured to include an introduction, the types, benefits and cost of agricultural technology, a definition of technology adoption, the technology adoption process, determinants of technology adoption, factors constraining the adoption of technology, ATA by smallholder commercial farmers in Ghana, the status of ATA by smallholder commercial farmers in Ghana, determinants of ATA by smallholder farmers in Ghana, factors constraining the adoption of technology by smallholder farmers in Ghana and the chapter summary.

Chapter Three contained the second part of the literature review on the theoretical framework of consumer behaviour strategies. It includes the introduction, consumer purchase decision, factors influencing consumer behaviour in the agricultural sector, consumer behaviour strategies, adoption theories, the theoretical framework of the study, the research setting and the chapter summary.

Chapter Four of the study presented the conceptual framework and hypotheses development. The chapter was structured under subheadings that include the introduction, elements of consumer behaviour, the conceptual framework and hypothesised relationships, the strategy timeline and the chapter summary.

Chapter Five consists of the research methodology that was used in the study. The chapter included an introduction, competing philosophical perspectives, the research approach, research design, the population and sampling techniques of the study, the sample size of the study, methods of data collection, validity and reliability, data analysis and the chapter summary.

Chapter Six of the study involved data analysis and discussion of findings with sections on the introduction, socio-demographic characteristics of participants, psychological behavioural elements, social behavioural elements, personal behavioural elements, ATA, the relationship between psychological behavioural elements and ATA among rice farmers, the relationship between social behavioural elements and ATA among rice farmers, the relationship between personal behavioural elements and ATA among rice farmers, the relationship between consumer behavioural attributes of farmers and adoption of agricultural technology, the goodness of fit indices - model validation, discussion of empirical results and chapter summary. Finally, Chapter Seven encompassed the summary of the report with concise conclusions and recommendations.

7.3 CONCLUSIONS ON THE RESEARCH OBJECTIVES

It is concluded that psychological, social and personal elements of consumer behaviour are very instrumental in getting smallholder farmers to accept and adopt agricultural technology. The farmer must be understood as a consumer; therefore, the consumer behaviour models are tailored to help them adopt and deploy technology in their farming activities. Consumer behaviour based on three behavioural elements (psychological, social and personal) strongly impacts farmers' adoption of technology. In the following conclusions, the results of the quantitative analysis are used to show that the research objectives were achieved.

Conclusion based on objective 1: The relationship between perceived usefulness of a technology and farmers' willingness to adopt agricultural technology.
At a 95% confidence level, a strong positive relationship exists between the psychological element - perceived usefulness and the farmer's willingness to adopt agricultural technology. The perceived usefulness of agricultural technologies improves adoption among farmers. The likelihood of agricultural technology being deemed less useful is only 5%. Here it is evident that the need for strategic intervention that allows a farmer to be both user and co-innovator of agricultural technology becomes increasingly important. Farmer’s need has become a strategic anchor in which agricultural technology should be developed, promoted and adopted for sustained food production. The importance and functional needs of any new innovative technology made available to farmers must be well tailored to this psychological dimension of farmers as consumers of agricultural technologies.

Conclusion with regard to objective 2: The correlation between perceived ease of use of a technology and farmers' willingness to adopt agricultural technology

It is concluded that ATA amongst farmers is positively influenced by perceived ease of use of the technology. Smallholder farmers are stimulated to adopting technology that is less challenging and less difficult to use. For example, the smallholder commercial rice farmer views the current technologies as easy and is therefore willing to adopt them. This information is important to stakeholders in the agricultural industry so that they introduce to farmers technologies that are easy to use as this forms part of farmer psychological behavioural traits to improve adoption of agricultural technology. On the other hand, if the technology is challenging to apply, the farmer would be reluctant to adopt it.

Conclusion with regard to objective 3: The relationship between peer influence and farmers' willingness to adopt agricultural technology.

Farmers' peers form the social factors in the consumer behaviour dimensions. The study concludes that farmers' behaviour towards adoption is also affected positively by peer influence and superior influence. Families, friends and colleague farmers can encourage farmers to change their behaviour towards adopting yield enhancing agricultural technology. Smallholder farmers pay attention to their peers and often trust their opinions and suggestions for using agricultural technology. Therefore, there is the likelihood of technology adoption amongst smallholder farmers to increase if peers play an influential role by convincing them to do so. It is concluded that Ghanaian smallholder farmer is more influenced by their peers than by their superiors in the industry in the decision to adopt agricultural technology. This is reasonable as peers appear to be more socially proximal than superiors who are socially distant. The word-of-mouth of friends, relatives and colleague farmers proved effective among Ghanaian farmers in adopting agricultural technology. Thus, farmers are more easily influenced by their peers to adopt technology than by the influence of superiors.

Conclusion with regard to objective 4: The relationship between superior influence and farmers' willingness to adopt Agricultural Technology

The study concludes that the superior influences of the agricultural extension officers, the scheme managers and agricultural programme administrators have a relationship with the farmers' willingness to adopt agricultural technology. The superior social members of farmers provide guidance, education, training, encouragement and motivation for farmers. However, it is observed in the study that farmers are more influenced by their peers who are colleague farmers, family relatives and friends than their superiors.

Conclusion with regard to objective 5: The connection between attitude and farmers' willingness to adopt Agricultural Technology

The study further concludes that farmers' personal behaviour is the most influential consumer behavioural element stimulating ATA. In this study, the attitude, level of self-efficacy, and complexity of the technology all characterise the consumer's personal behaviour. Technology adoption is positively impacted by the mindset of smallholder farmers. A considerable likelihood of adoption was sparked by farmers' positive attitudes towards technologies that increased yield. Adoption of technology is predicted favourably by smallholder farmers' attitudes. A positive attitude of a farmer changes their behaviour, thus increasing the likelihood of adopting technology.

In its sixth objective, this study investigates the relationship between self-efficacy and farmers' willingness to adopt agricultural technology. The study concludes that farmers' self-efficacy also positively influences technology adoption. Increasing the capability and belief of farmers that they can use agricultural technology increases the chance of adoption. A strong sense of self-efficacy or belief among farmers enhances their accomplishments towards technology adoption.

The relationship between the complexity of technology and farmers' willingness to adopt agricultural technology is also investigated in the seventh objective of the study. Among the three personal behavioural elements, complexity negatively influences ATA. On the other hand, when smallholder commercial farmers find agricultural technology less complex to use, this increases their willingness to adopt it. Therefore, these behavioural elements must be considered and frequently given priority to increasing technology adoption among farmers.

Finally, a technology adoption strategy is created based on the relationships between consumer behaviour traits and Ghanaian farmers' propensity to accept agricultural technology. This strategy takes into account the psychological, social and personal behavioural dimensions of farmers to increase the adoption of agricultural technology by Ghanaian farmers for enhancing yield, ensuring food security, eradicating poverty and achievement of both SDGs (SDGs 1,5,8) and Ghana's Long-Term National Development Plan (LTNDP, 2018-2057). The strategy uses agricultural technology to incorporate farmers' past, present, and emerging experiences. For example, in the past, farmer experience using agricultural technology was not as pleasant as it is currently experienced.

Psychologically, farmers perceived the agricultural technology employed in the past as not easy to use and not as useful as it is in the present. Also, the superior influence of agriculture extension officers, scheme managers and programme administrators were lacking in the past as farmers did not have access to these social elements. However, the current peer influence on the farmers to adopt agricultural technology is the same as in the past. On the personal dimension, farmers were not as optimistic in their attitude in the past as they are now adopting agricultural technology. Likewise, in the past, farmers' beliefs regarding their ability to use current agricultural technology were not strong as in the present. However, despite the lack of confidence in the past, farmers did not see the technology they used today as complex.

7.4 RECOMMENDATIONS

This section outlines the recommendations for professional practice, for policy implementations and for future research.

7.4.1 Recommendation for practice

Based on the findings of this study, it is important that stakeholders in the agricultural sector see the marketing theory of consumer behaviour as a major instrument worth relying on to persuade farmers to accept and adopt policies and strategies for agricultural growth, including technology. Therefore, new innovations and the introduction of technologies in the agricultural sector must strongly consider marketing concepts such as consumer behaviour as a means of consumer sensitization and commercialisation. Without intensive knowledge and insight into changes in the farmer's behaviour and planning accordingly, any policy or agricultural enhancing technology thrown at them may fail.

In order to achieve food security for all and guarantee that people have regular access to adequate high-quality food, the Food and Agriculture Organization (FAO), a specialised agency of the United Nations, is in charge of leading global efforts to end hunger. Farmers in Ghana and throughout Africa must be encouraged to use innovative agricultural technologies in order to increase production and guarantee food security if FAO's aim is to be met. The results of this study showed a positive association between farmers' willingness to adopt agricultural technology to increase food security and lessen rural poverty among farmers and the psychological, social, and personal consumer behavioural characteristics of farmers. Therefore, when implementing regional programmes, FAO, as an international body, should consider, among other things, the consumer behavioural characteristics of farmers. For instance, research would be undertaken to evaluate the consumer behaviour of farmers in the locations before determining which agricultural technology to deploy there. The current study demonstrates that agricultural technologies that are simple to use are preferred over those that are useful and that peer influence over superior influence is stronger when it comes to the adoption of agricultural technology, just like in the case of Ghana's smallholder commercial farmers. It is therefore recommended that the FAO, the Non-Governmental Organizations (NGOs) with interest in agriculture and the policymakers in the agricultural sector team up with MoFA, to establish peer mentoring programmes that enable the more experienced farmers to mentor, support and educate less experienced ones to enhance adoption of agricultural technology. As farmers develop a positive attitude towards the employment of agronomic innovations, farm yields increase, food security is guaranteed, and rural poverty among farmers is alleviated.

Smallholder farmers should also be well educated and constantly trained on the importance and application of technology in farming activities. Farmers should also be constantly communicated to on the changing needs that demand the use of technology to boost yield and productivity. These strategies will help increase perceived usefulness and perceived ease of use of agricultural technology amongst farmers. New inventions and innovations should be made simple to entice farmers to use them. Since farmers seem to be more identified with peer influence than superior influence, the "superiors" should channel their messages to farmers through their peers. Farmers should also be encouraged and motivated to stimulate positive attitudes and self-efficacy among farmers towards technology adoption.

The study further recommends an adoption strategy framework for policy implementation. Plans for achieving future ATA goals are laid out using an adoption strategy framework. The adoption strategy framework examines where farmers were in terms of adoption in the past and in the present, and it shows how farmers may get to where they need to be in terms of adopting agricultural technology. It offers a structured format that clearly specifies objectives, means of achieving them, and their intended use. The adoption strategic framework is crucial to provide stakeholders in the agricultural industry a point of focus, raise the likelihood that farmers will accept agricultural technology, and ensure that everyone is working towards the same objective.

The adoption strategy framework should include the ATA in the past and present and the strategic alternative to the adoption of emerging agricultural technologies. In the past, agriculture productivity has remained low due to a lack of adoption of improved agricultural technologies. Agriculture used to be primarily reliant on rainfall. Irrigation technologies were few. The usage of agricultural inputs was erroneous. Cutlasses and hoes were used as farming instruments; hence agriculture was labour-intensive. These technologies were readily available in the local market. Improved rural infrastructure, portable water, and power were among the government's measures to assist farmers. Attempts to restructure the agricultural sector extend back to the post-independence period, when the government invested in private and public products to boost farm output.

Currently, Ghana continues to struggle with food insecurity, a lack of appropriate government incentives in the agricultural sector, and rising farmer poverty. Ghana's agricultural productivity has been slowly increasing due to improvements in agricultural technology usage. Poor use of drone technology to spray pesticides, inefficient use of farming inputs (better seed, Fertiliser, herbicides, and pesticides), low agricultural mechanization, reliance on rainfed agriculture, and limited use of labour-saving technologies (herbicides and mechanization: ploughing) are just a few examples. In addition, farmers have switched from long-maturing to short-maturing crop kinds crops (Houssou et al., 2016a; 2016b). As a result of these approaches, agriculture's contribution to GDP increased from 2.9 % in 2014 to 20.1% in 2020. Currently, Fertiliser recommendations are made without regard to soil fertility patterns or crop nutrient requirements, resulting in inadequate fertiliser yield responses (Chapoto and Tetteh, 2014).

The importation of tractors via bilateral agreements to offer farmers at subsidised prices is one example of government support for agricultural development. Furthermore, there are subsidies for farming inputs and a seed policy that allows for more private participation. In addition, private mechanisation centres, such as Agricultural Mechanization Services Centers (AMSEC), have been subsidised by the government since 2007. However, equipment capacity utilisation has been low, administrative costs have been high, and a spare parts network has been lacking (Houssou et al., 2016a; 2016b).

The strategic option for Ghana's agricultural sector is to employ emerging agricultural technologies together with the right mix of the consumer behavioural traits of the farmers to help Ghana achieve the SDGs by 2030. Ghana requires more agricultural equipment not only for tillage but also for harvesting and shelling. The spread of information platforms via mobile phones in local languages to educate, inform, and train farmers in the use of farming inputs and automation could be one of the farmer education technologies under farmers' psychological, social and personal characteristics. Farmers can focus more on boosting overall crop yields by using easy-to-use robotic devices to automate slow, repetitive, and boring jobs. Harvesting and picking, weed control, mowing, pruning, sowing, spraying and thinning, sorting and picking are only some of the applications for robotics systems. As farmers develop positive attitudes towards these technologies through training by individuals in their social environment, increasing their adoption will achieve food security. Also, farmers can use GPS technology to navigate to specified spots in the field to take soil samples or check crop conditions year after year. The farmers will favour a simple, not complex, GPS technology. Additionally, precision agriculture (PA) is a type of farm management that employs information technology to ensure that crops and soil get what they need to thrive and produce at their best. In this vein, Government should develop a learning environment for agricultural information technology that enables farmers to employ GPS. This information technology learning infrastructure should enhance superior social members' technology training together with the peer mentors of farmers to increase the adoption of surveillance technologies. Furthermore, an automated irrigation system is also available on the online marketplace. This technology requires no or very little operator involvement. However, several of these technologies are not available in Ghana. Therefore, the government should facilitate farmer groups' importation or ease access to the technology by subsidising its acquisition. It is vital to develop strategies that cognise farmers' psychological, social, and personal characteristics to enhance the adoption of these technologies to increase farm yields, achieve food security, reduce poverty, and create decent jobs for rural farmers.

7.4.3 Recommendation for research

This study can be extended to other sectors of the economy regarding technology adoption. It is also observed that behavioural elements such as perceived usefulness and complexity are interconnected. It will be interesting to examine the mediation role of complexity in the relationship between perceived ease of use and technology adoption. Moreover, the literature revealed the importance of demographic and cultural factors such as experience, educational level, age, and others influencing behaviour and adoption. A further study should be conducted to determine the role of these variables in the relationship between consumer behaviour elements and technology adoption.

7.4.3 Recommendation for policy

The agribusiness policies aim to encourage a sector that is more responsible, sustainable, and innovative. The Agricultural Sector Policy Note in Ghana is specifically made to achieve the modernization and transformation of the agricultural sector for economic development, job creation, and food security. The implementation of this strategy is essential since agribusiness employs over half of the workforce, contributes to one fifth of Ghana's GDP, and serves as the primary source of income for the vast majority of the nation's poorest households (MoFA, 2017). In order to encourage farmers to accept technology, the policy should attempt to develop links between research and extension. For these goals to be achieved, it is essential that the findings of this research are implemented to increase adoption of agricultural technology among smallholder commercial farmers.

According to the findings of the study, farmers' perceptions on the perceived usefulness of agricultural technology have less of an impact on their psychological characteristics compared to the perceived ease to use. This implies that farmers would reject agricultural technology regardless of its usefulness if they thought it was difficult to use. As a result, the Ministry of Food and Agriculture (MoFA), which is the lead agency and focal point of the Government of Ghana and is in charge of developing and implementing policies and strategies for the agricultural sector with the goals of ensuring food security, enhancing farmers' income growth, and being prepared for emergencies, should first establish a learning environment where farmers can practice using new technologies. For instance, MoFA should improve the technical training provided to agricultural extension officers and provide peer mentoring to farmers. These opportunities for training in the application of agricultural technologies increase farmers' self-efficacy and value beliefs, strengthening their attitudes toward the use of agricultural technology. The study found that farmer attitudes are primarily responsible for individual consumer behavioural patterns. A significant association has been observed between the willingness of farmers to adopt agricultural technology and the agricultural extension officers, as well as the farmers' friends, relatives, families, and co-workers, which comprise the peer influence. According to the study, peer influence has a greater impact on a farmer's social qualities than superior influence. In light of this finding, the Ministry of Food and Agriculture may create a peer mentoring position that entails giving peer help and advice in agronomy. Peer mentors can be utilised to enlighten farmers on the application and accessibility of new technology, provide knowledge about resources and services available to improve farm operations and recommend farmers to any sources with more clout.

7.5 LIMITATIONS OF THE STUDY

This study offers intriguing insights into the smallholder commercial rice farmers in Ghana's adoption of agricultural technology from the consumer behaviour perspective. However, despite these conclusions, several limitations must be considered.

First, the study has certain theoretical limitations. The Technology Acceptance Model was employed in the investigation (TAM). Researchers have widely used TAM. The theory has, however, been criticised for its flaws, particularly in light of its constrained theorization of factors influencing the adoption of technology (Ajibade, 2018). The theory has drawn criticism for being overly simple and having few real-world applications (King and He, 2006; Ajibade, 2018). The theory is criticized for being overly simple since it presupposes that Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) constructs are the two primary elements that affect a person's decision to embrace and use innovation or technology (Davis, 1989). Some academics contend that by emphasising the significance of PEOU and PU in encouraging consumers to accept new technologies, TAM has significantly simplified the theoretical framework for technology adoption (Giovanis et al., 2012).

Second, while the study's sample was large enough to be representative of smallholder commercial rice producers, it was limited to Ghana in West Africa. Since the agricultural technology infrastructure available to smallholder commercial rice producers varies in different regions, the choice of Ghana limits the capacity to generalize the results. Farmers in Asia, for instance, have access to different agricultural technology than those in Europe and other regions of the world. Nevertheless, they may share common features and as well have differences. The study's findings represent only the adoption behaviour of Ghanaian smallholder commercial rice farmers. In order to uncover the parallels and differences that exist in each region, comparative research should be conducted to reproduce the findings in this study. In addition, there are many other crop farmers. These farmers may show different adoption behaviour of agricultural technology.

Finally, the study only used cross-sectional data collection to examine smallholder commercial rice farmers' adoption behaviour. A longitudinal investigation could have been preferable. This is because research on technology adoption shows that a strategic timeline of the consumer's prior experiences and current experiences is necessary to determine the behaviour towards adopting new technologies. So, a person's prior experience using new technology may create obstacles or opportunities for future technology adoption (Belk et al., 2021; Scott et al., 2019; Son & Han, 2011; Au & Enderwick, 2000). However, the study's capacity to forecast strategic options that are properly based on the farmers' cumulative experience was constrained by the cross-sectional data that was collected and analysed.

7.6 CHAPTER SUMMARY

The conclusions and recommendations of the study are provided in this chapter. The findings of the study suggest that farmers' psychological, social, and personal traits are positively correlated with their willingness to adopt agricultural technology and should be taken into account at all times to increase the adoption of this technology. Farmers use agricultural technologies. Therefore, their opinions of how simple and practical they are to use are important for determining whether or not they will be adopted. Additionally, peer social members have a stronger influence on farmers' adoption of agricultural technology than distant superior social members. Furthermore, a farmer's personal traits are very important since the adoption of agricultural technology is strongly correlated with a farmer's sense of self-efficacy, optimistic outlook, and beliefs. Farmers are hesitant to accept agricultural technology because of its complexity. The study recommends that the Government of Ghana, through the Ministry of Food and Agriculture (MoFA), policymakers in the agricultural sector, Non-Governmental Organizations (NGOs) with interest in agriculture, and the Food and Agriculture Organization (FAO) of the United Nations, take into consideration the psychological, social, and personal characteristics of farmers when designing training needs of farmers to enhance the adoption of agricultural technology to improve farm yields, reduce rural poverty, hunger, ensure food security and create decent jobs for farmers for the achievement of the United Nation's SDGs (Goals 1, 2, 8), the African Union's Agenda 2063 (Goal 5) and Ghana's Long-Term National Development Plan (LTNDP, 2018-2057) by 2030, 2063 and 2057 respectively.

APPENDIX I Scoring System for Variables

Table Appendix 1. 1**:** Scoring System for Variables

Scale	Range of Weighted Mean	Response Scale
5	4.2 – 5.0	Strongly agree
4	3.4 – 4.1	Agree
3	2.6 – 3.3	Neutral
2	1.8 – 2.5	Disagree
1	1.0 – 1.7	Strongly disagree

Source: Adokou (2022)

APPENDIX II The Research Questionnaire

Dear Participant,

You are invited to participate in a study that will look at consumer behaviour in relation to agricultural technology adoption strategies for smallholder commercial rice producers in Ghana. This survey is being conducted to gather first–hand data for academic purposes. Fertiliser application, improved seeds, irrigation, greater soil tillage, integrated pest management, and mechanisation are all examples of agricultural technology used in this study.

Before you continue, please understand that your participation is entirely voluntary. You have the option to leave the survey at any moment. Your privacy has been protected to the fullest extent possible. As a result, we do not require you to provide your name, email address, phone number, or any other information that can be directly or indirectly linked to you. The identity of the participants will be kept private. Your responses are kept confidential. The completion of this survey is considered your informed consent to participate in this research investigation.

Thank you in advance for you time.

A. DEMOGRAPHIC INFORMATION

Please indicate the number of years you have been farming rice

_____ 1 to 2 years

_____ 3 to 5 years

_____ 6 to 10 years

_____ 11 to 15 years

_____ More than 15 years

_____ Prefer not to say

What gender do you identify as?

_____ Male

_____ Female

_____ Prefer not to answer

What is your age?

_____ 18 to 24

_____ 25 to 34

_____ 35 to 54

_____ 55 and above

_____ Prefer not to answer

Where are you located?

_____ Volta North

_____ Central Volta

_____ Volta South

_____ Prefer not to answer

Please specify your ethnicity

_____ Akan

_____ Ewe

_____ Ga–Dangme

_____ Guan

_____ Mole–Dagbani

_____ Other

_____ Prefer not to say

What is the highest level of education you have completed?

_____ No Education

_____ Basic Education (Primary and Junior Secondary Education)

_____ Secondary Education (Senior Secondary Education)

_____ Tertiary Education (University, Polytechnic, etc.)

_____ Prefer not to say

What is your annual income from rice farming (GHC)?

_____ Less than 5,000

_____ 5,000 to 10,000

_____ 10,000 to 20,000

_____ 20,000 and above

_____ Prefer not to say

Are you married?

_____ Yes

_____ No

_____ Prefer not to say

How many children do you have?

_____ None

_____ 1
_____ 2 to 4
_____ 5 to 7
_____ 8 and above
_____ Prefer not to say

If applicable, please specify your religion

_____ Christian
_____ Islamic
_____ African Traditional
_____ Other
_____ Prefer not to say

B. PSYCHOLOGICAL BEHAVIOURAL ELEMENTS

Instructions: On the Likert Scale of 1 to 5, Please answer each question to indicate the extent to which you agree or disagree with the following statements with: 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree

S/N	Behavioral Dimensions	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
1	Using yield enhancing agricultural technology helps me increase productivity	1	2	3	4	5
2	Using yield enhancing agricultural technology helps me be effective at farming	1	2	3	4	5
3	Using yield enhancing agricultural technology helps me save time	1	2	3	4	5
4	Using yield enhancing agricultural technology helps me work more quickly	1	2	3	4	5
5	Using yield enhancing agricultural technology helps me accomplish more work	1	2	3	4	5
6	Using yield enhancing agricultural technology helps me increase the quality of my work	1	2	3	4	5
7	Using yield enhancing agricultural technology helps me address my farming needs	1	2	3	4	5

8	Using yield enhancing agricultural technology helps me have control over my work	1	2	3	4	5
9	My job will be difficult without using yield enhancing agricultural technology	1	2	3	4	5
10	With yield enhancing agricultural technology, my jobs are made easier	1	2	3	4	5
11	Some years ago, the yield enhancing agricultural technologies I used were as useful as the ones I use today	1	2	3	4	5

S/N	Behavioral Dimensions	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
1	Learning to use yield enhancing agricultural technology was easy for me	1	2	3	4	5
2	I found it easy to apply instructions on yield enhancing agricultural technology	1	2	3	4	5
3	I found yield enhancing agricultural technology instructions clear and understandable	1	2	3	4	5
4	I found yield enhancing agriculture technology easy to use	1	2	3	4	5
5	Steps involved in applying yield enhancing agricultural technology are easy to remember	1	2	3	4	5
6	It is easy to become skillful at using yield enhancing agricultural technology	1	2	3	4	5
7	I found yield enhancing agricultural technology flexible to use	1	2	3	4	5
8	Some years ago, the yield enhancing agricultural technologies I used were as easy to use as the ones I use today	1	2	3	4	5

C. SOCIAL BEHAVIOURAL ELEMENTS

Instructions: On the Likert Scale of 1 to 5, Please answer each question to indicate the extent to which you agree or disagree with the following statements with:

1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree

S/N	Behavioral Dimensions	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**

1	My friends think I should use yield enhancing agricultural technology	1	2	3	4	5
2	My relatives would want me to use yield enhancing agricultural technology	1	2	3	4	5
3	My colleague farmers think I should apply yield enhancing agricultural technology	1	2	3	4	5
4	My neighbours would want me to use yield enhancing agricultural technology	1	2	3	4	5
5	I feel under social pressure to use yield enhancing agricultural technology	1	2	3	4	5
6	I use yield enhancing agricultural technology because other farmers do the same	1	2	3	4	5
7	My family approves my usage of yield enhancing agricultural technology	1	2	3	4	5
8	Some years ago, the influence of my peers to use yield enhancing agricultural technology was as effective as it is today	1	2	3	4	5

S/N	Behavioral Dimensions	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
1	I see Agriculture Extension Officers as very important in my work as a rice farmer	1	2	3	4	5
2	I value opinions of Agricultural Extension Officers	1	2	3	4	5
3	Agricultural extension officers have a great impact on the kind of yield enhancing agricultural technology I use	1	2	3	4	5
4	I use yield enhancing agricultural technology that agricultural extension officers approve of	1	2	3	4	5
5	I use yield enhancing agricultural technology because Agricultural Extension Officers think I should use	1	2	3	4	5
6	Agricultural Extension Officers would want me to use yield enhancing agricultural technology	1	2	3	4	5

7	I usually do what Agriculture Extension Officers expert me to do	1	2	3	4	5
8	Some years ago, the availability and guidance of Agricultural Extension Officers to use yield enhancing agricultural technology was as accessible as it is today	1	2	3	4	5

D. PERSONNAL BEHAVIOURAL ELEMENTS

Instructions: On the Likert Scale of 1 to 5, Please answer each question to indicate the extent to which you agree or disagree with the following statements with:

1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree

S/N	Behavioral Dimensions	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
1	For me, using yield enhancing agricultural technology is good	1	2	3	4	5
2	For me, using yield enhancing agricultural technology is desirable	1	2	3	4	5
3	For me, using yield enhancing agricultural technology is valuable	1	2	3	4	5
4	For me, using yield enhancing agricultural technology is ethical	1	2	3	4	5
5	Using yield enhancing agricultural technology is impossible for me	1	2	3	4	5
6	My using yield enhancing agricultural technology is challenging	1	2	3	4	5
7	I will always use yield enhancing agricultural technology in my farming	1	2	3	4	5
8	Some years ago, I felt good using yield enhancing agricultural technologies as I feel today	1	2	3	4	5

S/N	Behavioral Dimensions	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
1	I feel confident I can use yield enhancing agricultural technology	1	2	3	4	5

2	I feel confident I can learn to use yield enhancing agricultural technology	1	2	3	4	5
3	I feel confident that when I use yield enhancing agricultural technology, I can increase my yield	1	2	3	4	5
4	I feel confident that I can apply different yield enhancing technologies to increase my produce	1	2	3	4	5
5	I feel confident that I can expand my farm with the help of yield enhancing agricultural technologies	1	2	3	4	5
6	I feel confident that I can find new ways to integrate yield enhancing technologies in my farming methods	1	2	3	4	5
7	I have the knowledge and ability to use yield enhancing agricultural technology	1	2	3	4	5
8	I felt confident to use yield enhancing agricultural technologies in the past as I feel today	1	2	3	4	5

S/N	Behavioral Dimensions	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
1	I feel that it takes a lot of effort to become skillful at using yield enhancing agricultural technology	1	2	3	4	5
2	Using yield enhancing agricultural technology is frustrating	1	2	3	4	5
3	Applying yield enhancing agricultural technology requires mental effort	1	2	3	4	5
4	I found application of yield enhancing agricultural technology confusing	1	2	3	4	5
5	I found yield enhancing agricultural technology instructions cumbersome	1	2	3	4	5
6	I found yield enhancing agricultural technology to be rigid and inflexible	1	2	3	4	5
7	Overall, I feel that yield enhancing agricultural technology is difficult to use	1	2	3	4	5

8	In the past the yield enhancing agricultural technologies were as difficult to use as they are today	1	2	3	4	5

E. ADOPTION

Instructions: On the Likert Scale of 1 to 5, Please answer each question to indicate the extent to which you agree or disagree with the following statements with:

1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree

S/N	Behavioral Dimensions	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
1	I intend to use yield enhancing agricultural technology in the future`	1	2	3	4	5
2	I expect that I use yield enhancing agricultural technology in my daily farming activities	1	2	3	4	5
3	I expect that I use yield enhancing agricultural technology frequently	1	2	3	4	5
4	I adopt the use of yield enhancing agricultural technology	1	2	3	4	5
5	I use yield enhancing agricultural technology in my daily farming activities	1	2	3	4	5
6	I will continue to use yield enhancing agricultural technology frequently.	1	2	3	4	5

THANK YOU

APPENDIX III: FARMERS AT WETA IRRIGATION SCHEME

WETA IRRIGATION SCHEME – SUMMARY DATA							
NO	**SECTION**	**BLOCK**	**MALE**	**FEMALE**	**SUB–TOTAL**	**TOTAL**	**PER%**
1	1AB	A	32	9	41		
		B	28	2	30		
			60	***11***	***71***	***71***	6.5
2	1CDE	C	39	5	44		
		D	40	10	50		
		E	16	1	17		
			95	***16***		***111***	10.1
3	2	A	5	1	6		
		B	12	4	16		
		C	16	3	19		
		D	14	0	14		
		E	9	1	10		
			56	***9***		***65***	5.9
4	3	A	16	5	21		
		B	18	3	21		
		C	14	4	18		
		D	12	2	14		
		E	9	2	11		
			69	***16***		***85***	7.8
5	4	A	24	4	28		
		B	17	9	26		
		C	20	6	26		
		D	19	7	26		
		E	13	3	16		
			93	***29***		***122***	11.1
6	5	A	17	15	32		
		B	18	6	24		

		C	18	3	21		
		D	15	5	20		
			68	***29***		***97***	8.8
7	6	A	19	5	24		
		B	16	5	21		
		C	12	5	17		
		D	8	3	11		
			55	***18***		***73***	6.7
8	7	A	20	2	22		
		B	21	7	28		
		C	11	8	19		
		D	12	5	17		
			64	***22***		***86***	7.9
9	8	A	15	7	22		
		B	16	5	21		
		C	14	5	19		
		D	17	7	24		
			62	***24***		***86***	7.9
10	9	A	14	7	21		
		B	15	6	21		
		C	12	8	20		
		D	15	5	20		
			56	***26***		***82***	7.5
11	10	A	24	9	33		
		B	16	6	22		
		C	16	8	24		
		D	33	6	39		
			89	***29***		***118***	10.8
12	11	A	18	8	26		
		B	12	8	20		
		C	18	4	22		
		D	25	6	31		
			73	***26***		***99***	9

			840	***255***		***<u>1095</u>***	100
			male	female		***<u>total</u>***	
			76.60%	23.40%			

	SECTION 1 A BLOCK	**PLOT SIZE**		
NO	**NAME OF FARMER**	**NO**	**HA**	**ACR**
1	AGBODJAN King Adote	A1	0.2	0.5
2	WEMEGAH Afagbedzi	A2	1.12	3
3	AMANU Akpene	A3	1.6	4
4	NUTEKPOR Dana	A4a	1	2.5
5	Adzo ADZIKA	A4b	0.6	1.5
6	Patrick Flovi	A4c	0.4	1
7	MORKLI Kadzashie	A5a	1	2.5
8	WEMEGAH Afagbedzi	A5b	0.6	1.5
9	Patience Morkli	A6a	0.4	1
10	ATITSOGBUI Christiana	A6b	0.4	1
11	AGBALE Rapheal	A6c	0.8	2
12	WEMEGAH Wofa Yaw	A7a	0.8	2
13	Suzaa Amamu	A7b	0.4	1
14	Modzaka Abotsi	A7c	0.4	1
15	ADZI Hudolo	A7d	0.4	1
16	Beauty Ametordjie	A8a	1.2	3
17	ADELAYITAH Kodzo	A8b	0.4	1
18	Moses Adelayitah	A8c	0.4	1
19	Kweku Dey	A9a	0.4	1
20	DATSOMOR Kofi	A9b	0.8	2
21	Mensah Lumor	A9c	0.4	1
22	Gershon Atatsi	A9d	0.4	1
23	AGBEDORWU Eyi	A10a	0.2	0.5
24	AGBODJAN King Adote	A10b	0.9	2.25
25	Gershon Atatsi	A10c	0.4	1
26	AMEGADZI Agarther	A11a	0.9	2.25
27	DZADZU Gamadeku Kwami	A11b	0.9	2.25
28	NUTSUKLO Gabriel	A12a	0.6	1.5
29	Believer Awuku A.	A12b	0.6	1.5
30	Famous Atitsogbui	A13	1.2	3
31	ATITSOGBUI Yao Agbota	A14	1.2	3
32	Kwabla Amamu	A15a	1.2	3
33	Kumadzi Hanyra	A15b	0.4	1
34	AGBAGBA Vincent	A16a	0.8	2
35	AGBAGBA Denis	A16b	0.8	2
36	Morgan Dem	A16c	0.4	1
37	Felix Yao FIATSI	A17	0.8	2

38	ATATSI Gabriel	A18a	0.4	1
39	AMAMU Prosper	A18a	0.4	1
40	DZADZU Gamadeku Kwami	A19b	0.4	1
	SECTION 1 B BLOCK			
41	ATATSI Yao	B4a	0.6	1.5
42	ADELAYITAH Benjamin	B4b	0.6	1.5
43	AHORDOSU Francis Adelayitah	B5a	0.4	1
44	NYIDEWU Kwaku	B5b	0.4	1
45	Kwabla Adelayitah	B5c	0.86	2.15
46	ALORGBODZI II Sarfoa Midao G.	B6a	0.86	2.15
47	GBETSIAFA Micheal	B6b	0.43	1
48	Francis Addayitah	B6c	0.2	0.5
49	ADELAYITAH Moses	B6d	0.2	0.5
50	ADELAYITAH Benjamin	B7a	0.86	2.15
51	FIATSI Johnson	B7b	0.86	2.15
52	ADELAYITAH Kwaku Daniel	B8a	0.86	2.15
53	WEMEGAH Gatepe Korbla	B8b	0.86	2.15
54	GAMENYA Kodzo	B9a	0.86	2.15
55	WEMEGAH Gatepe Korbla	B9b	0.86	2.15
56	AHORDOSU Dangoe	B10a	0.43	1
57	SODOH Roland	B10b	0.43	1
58	AGOZIE Philomina	B10c	0.86	2.15
59	KWAO James	B11	1.72	4.3
60	AHORDOSU Midao	B12a	0.86	2.15
61	AHORDOSU Godsway	B12b	0.86	2.15
62	AMAGLO David Kwasi	B13a	0.86	2.15
63	AGBO Daglobo	B13b	0.86	2.15
64	NUTEKPOR Yaovi	B14	1.72	4.3
65	AGOZIE Stanley	B15	1.72	4.3
66	AMAMU Kwabla	B16a	0.86	2.15
67	SALLAH Thomas	B16b	0.86	2.15
68	ADORSU Dogbe	B17	1.72	4.3
69	AKPALU Francis	B18	1.72	4.3
70	AMAMU Kordzo	B19	1.72	4.3
	SECTION 1 C BLOCK			
71	NUTEKPOR Wonder	C1	0.9	2.25
72	James Kwasi Lavi	C2	0.9	2.25
73	DZAMESHIE Amavi	C3a	0.52	1.3
74	DEKU Akakpo	C3b	0.52	1.3
75	NUTEKPOR Albert	C4	1	2.5
76	GBORGLAH Kwabla	C5	1.07	2.6
77	AWUSAH Feller	C6a	0.8	2
78	MENSAH Adefordzi	C6b	0.4	1

79	Kwashiwor Gborglah	C7a	0.4	1
80	Lorni BADA	C7b	0.2	0.5
81	Dazuhoe Doe	C7c	0.2	0.5
82	ADUKPO Adona	C7d	0.6	1.5
83	DAGBUI Dodzi	C8a	0.8	2
84	Afagbedzi Asravor	C8b	0.8	2
85	Saviour Dzamla	C9a	0.93	2.3
86	Cephas Afedo	C9b	0.93	2.3
87	ALORGBODZI Afi	C10a	0.93	2.3
88	AGBALE Kofi	C10b	0.93	2.3
89	AMAMU Emmanuel	C11a	0.93	2.3
90	AGBALE Mamagah	C11b	0.93	2.3
91	AKLIKA Comfort	C12a	0.93	2.3
92	Papah Zikpui	C12b	0.4	1
93	Rose Akrobotu	C12c	0.4	1
94	AMAGLO Harrison	C13a	0.93	2
95	AKLIKA Joshua	C13b	0.93	2
96	KLUTSEY Simon	C14B	0.93	2.3
97	KWATSIKOR James K.	C14A	0.93	2.3
98	Kofi Misakpor	C15a	0.465	1.1
99	Manorgbe Agbodza	C15b	0.465	1.1
100	FIANU Akakpo	C15c	0.465	1.1
101	Seth Gavor	C16a	0.465	1.1
102	AWUDI Martin	C16b	0.465	1.1
103	AKPOBI Wisdom Doe	C16c	0.465	1.3
104	AMEVOR David	C17a	0.93	2.3
105	AZAMETI Benjamin	C17b	0.93	2.3
106	TSIKPO Alex Kwesi	C18a	0.93	2.3
107	Michael Agbanyo	C18b	0.465	1.1
108	DARA Yao	C18d	0.465	1.1
109	FLOVI Patrick	C18c	0.93	2.3
110	Dogbevi Agbale	C19b	0.93	2.3
111	EDOR Francis	C19c	0.465	1.1
112	NUGONU Kwashie	C19d	0.93	2.3
113	KWATSIKOR Michael	C20a	0.9	2.25
114	KWATSIKOR Jimmy	C20b	0.9	2.25
	SECTION 1 D BLOCK			
115	ADZITO Juliana	D1a	0.4	1
116	TSIFOFOR Kwasiwor	D1b	0.4	1
117	ALI Dzanshie	D1c	0.4	1
118	Divine TETTEY	D1d	0.4	1
119	Ekpe Agbate	D1e	0.4	1
120	ANYIGBA Gabriel Kwasi	D2a	1	2.5

121	Mensah Agbodza	D2b	1	2.5
122	AVORGAH Dickson	D3a	1	2.5
123	Bernice ALORGBODZI	D3b	1	2.5
124	AKPALU Alavi Xornam	D4a	1	2.5
125	Daglobo Agbo	D4b	1	2.5
126	Benedicta GLIKU	D5a	0.5	1
127	ALARVIE Christopher	D5b	0.5	1
128	TORGUI DATEY	D5c	0.4	1
129	AGLONU Lawson	D5d	0.4	1
130	AZAGBE Klu	D6	1.8	4.5
131	DALETE George	D7a	0.43	1
132	DORNYO Martin	D7b	0.43	1
133	WOANA Kwaku	D7c	0.85	2.1
134	FOSTER Akpalu	D8a	0.85	2.1
135	DEM Moses	D8b	0.85	2.1
136	Rapheal Larvie	D9a	0.85	2.1
137	KORNIE Matthew	D9b	0.85	2.1
138	AGBAGBA C. K.	D10a	0.85	2.1
139	Oscar Deku	D10b	0.85	2.1
140	Isifi Alorgbodzi	D11a	0.56	1.4
141	ALORGBODZI II Sarfoa Midao G.	D11b	0.56	1.4
142	Kwashiwor Alavie	D11c	0.56	1.4
143	TRETU Moses	D12a	0.8	2
144	ALORGBODZI Ami	D12b	0.4	1
145	MENSAH Emmanuel	D12c	0.4	1
146	FLOVI Kwame	D13a	0.8	2
147	AGBALE Atise	D13b	0.8	2
148	TOGBUI NATTAH	D14a	0.8	2
149	FIASE Vincent	D14b	0.8	2
150	DZIVENU Afiwor	D14c	0.4	1
151	Norviegbor ALORGBODZI	D15a	0.4	1
152	ALORGBODZI Kugblenu	D15b	0.4	1
153	ALORGBODZI Sedewodzi	D15c	0.4	1
154	AGBALENYO Francis	D15d	0.4	1
155	DEDZO Midim Fofoe	D16a	0.8	2
156	Famous Fatsawu AGBALE	D16b	0.8	2
157	Saviour AGBALE	D16c	0.8	2
158	AHIATROGAH Afayome	D17a	0.8	2
159	AGBALE Segbedzi	D17b	0.8	2
160	AGBALE Amuzuvi	D18	1.4	3.5
161	Alofonshie Dzamasi	D19a	0.7	1.75
162	ADUKPO Jonathan	D19b	0.7	1.75
163	AGBALE Dawuso	D20a	0.7	1.75

164	FLOVI Atsitsogbui	D20b	0.7	1.75
	SECTION 1 BLOCK E			
165	Gideon Adukpo	E1a	0.4	1
166	NUTAH Gabriel	E1b	0.4	1
167	DUNYO Raphael Kofi	E2	1.3	3.25
168	AKPALOO Samuel	E3a	0.8	2
169	AKPALOO Stephen	E3b	0.8	2
170	ATITSOGBUI Mensah	E4a	0.8	2
171	ATITSOGBUI Kpomorne	E4b	0.8	2
172	AMAGLO Obimpeh	E5a	0.75	1.8
173	AMAGLO Kofi Henry	E5b	0.75	1.8
174	AKPALU Alarvi Xornam	E6a	0.4	1
175	DEDZOE Edward Kwaku	E6b	0.8	2
176	ALAVI Henry	E7a	0.6	1.5
177	BADA Lorni	E7b	0.6	1.5
178	Selasie Keku	E8	1	2.5
179	AGBALE Solomon	E9	0.9	2.25
180	Dogbevi AGBALE	E10	1.95	4.8
181	AGBALE Yaovi	E11	2	5
	SECTION 2 BLOCK A AND B			
182	Elizabeth Dogbey	2A6	0.4	1
183	Atsu Klokpodzi Richard	2A7	0.5	1.25
184	Sampson Dormenyo Korsi	2A8	0.2	0.5
185	Simon Ahorsu	A9	0.4	1
186	P.T.A Larve School	A10a	0.4	1
187	Adelayitah Kwaku Daniel	A10b	0.4	1
	SECTION 2 BLOCK B			
188	NYIDEWU Daniel	B1a	0.9	2.25
189	Sampson Dormenyo Korsi	B1b	0.9	2.25
190	Kwaku Dzotefe	B2	1.8	4.5
191	Kofi Ahordosu	B3	1.8	4.5
192	Atakpui Dzotefe	B4	1.8	4.5
193	Christopher Adelayitah	B5a	0.9	2.25
194	Dovi Adelayitah	B5b	0.9	2.25
195	Christian Adelayitah	B6a	0.9	2.25
196	Xorvey Adelayitah	B6b	0.9	2.25
197	Gbeda Dzotefe	B7a	0.9	2.25
198	Worla Azah	B7b	0.9	2.25
199	Yao Gbafa	B8a	0.9	2.25
200	Mark Dogbatse	B8b	0.9	2.25
201	Samuel Boatey	B9	1.8	4.5
202	Wisdom Ahordosu	B10a	0.9	2.25
203	Peace Kportufe	B10b	0.9	2.25

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	SECTION 2 BLOCK C			
204	Godson Amanglo	C1a	0.85	2.125
205	Hope Awagah	C1b	0.85	2.125
206	Stephen Seitu	C2a	0.85	2.125
207	Seth Seitu	C2b	0.85	2.125
208	Promise Gborglah	C3a	0.85	2.125
209	Evans Gborglah	C3b	0.85	2.125
210	Kwadzo Gborglah	C4	1.7	4.25
211	Ayitsey Mikado	C5a	0.42	1.05
212	Ami Mikado	C5b	0.42	1.05
213	Mawuli Mikado	C5c	0.85	2.125
214	Kwadzo Akpbobi	C6a	0.85	2.125
215	Moses Kporvuvu Adukpo	C6b	0.85	2.125
216	Seth Mikado	C7a	1.87	4.675
217	Tornam Azumah	C7b	0.4	1
218	Albert Deku	C8a	0.85	2.125
219	Moses Deku	C8b	0.85	2.125
220	Paulina Adzaklo	C9	1.7	4.25
221	Kodzo Agbenator	C10a	0.85	2.125
222	Kodzo Lokpa	C10b	0.85	2.125
	SECTION 2 BLOCK D AND E			
223	Awuku Gborglah	D1	1.7	4.25
224	Mensah Gborglah	D2	1.7	4.25
225	Gbede Gborglah	D3	1.7	4.25
226	Kwaku Famous Gborglah	D4	1.7	4.25
227	Peter Agbeko Freeman	D5a	0.85	2.125
228	Anthony Nutorwuli	D5b	0.85	2.125
229	Yao Agbenu	D6	1.7	4.25
230	John Tsawordzi	D7a	0.85	2.125
231	Israel Huzey Essor	D7b	0.85	2.125
232	Adzi Gbedemah	D8a	0.85	2.125
233	Husongbo Morkli	D8b	0.85	2.125
234	Mathias Tretu	D9a	0.85	2.125
235	TOGBUI NATTAH	D9b	0.85	2.125
236	Fredrick Leckey	D10	1.7	4.25
	TOTAL			
237	Kwabla Nuwortsi	E1	0.9	2.25
238	Charles Awudi	E2	0.8	2
239	Atitsogbui Flovi	E3	0.8	2
240	Nani Kwawu	E4	0.8	2
241	David Ocloo-Kwawu	E5	0.8	2
242	Mawuena-Avorgah Charllote	E6	0.8	2
243	Daklu Awudi	E7	0.9	2.25

244	Klutse Kwawu	E8	0.9	2.25
245	Clemence Yaogah Tsikata	E9	0.9	2.25
246	Kplorla Kwawu	E10	0.9	2.25
	SECTION 3 BLOCK A			
247	Agnes Adzo Nutsukpui	3A1	1	2.5
248	James Agbodzi Funu	3A2a	1	2.5
249	Daniel Axorlu	3A2b	0.8	2
250	Kofi Agbanyo	3A3a	1	2.5
251	Kwadzo Fiase	3A3b	0.6	1.5
252	ISamuel Aklika	3A4a	1	2.5
253	Kofi Aforla	3A4b	1	2.5
254	Joseph Adukpo	3A5a	1	2.5
255	Atitsogbui Tedzi	3A5b	1	2.5
256	Denis Gameli	A6a	1	2.5
257	John Tublu	A6b	1	2.5
258	Micheal Gbugbortey	A7a	0.5	1.25
259	Francis Tedzi	A7b	0.5	1.25
260	Emmah Atokple	A7c	1	2.5
261	Cudjoe Agblegui	A8a	1	2.5
262	Georgina Kudzawu	A8b	0.5	1.25
263	Ami Dogbe	A8c	0.5	1.25
264	Patience Morkli	A9a	1	2.5
265	Kwaku Zikpi	A9b	1	2.5
266	Anukware Samuel Agbolosu	A10a	1	2.5
267	Kennedy HUKPORTI	A10b	1	2.5
	TOTAL			
	SECTION 3 BLOCK B			
268	Adugba Agblegui	3B1a	1	2.5
269	Agbota Dodzi Dogbetor	3B1b	1	2.5
270	Dowuli Akaglah	3B2a	1	2.5
271	Christian Yador	3B2b	1	2.5
272	Atitsogbui Alarvie	B3	1.84	4.6
273	Noah Akumani	B4	1.84	4.6
274	Kwashie Ahiataku	B5a	0.92	2.3
275	John Adelayitah	B5b	0.92	2.3
276	Kordzo Paul AFATSIAWU	B6a	0.92	2.3
277	AGBODJAN King Adote	B6b	0.92	2.3
278	Fredrick Alarvie	B7a	0.92	2.3
279	Agbodzi Fianyo	B7b	0.92	2.3
280	Sylvester Agbanyo	B8a	0.5	1.25
281	Yaw Alarvie	B8b	0.5	1.25
282	George Solagah	B8c	1	2.5
283	Ablordey Etse D K	B9a	0.48	1.2

284	Kumah Sanefu	3B9b	0.48	1.2
285	Daniel Agbale Midawo	3B9c	0.96	2.4
286	Ben Kwasi Letsu	3B10a	0.96	2.4
287	Kwabla Adukpo	3B10b	0.48	1.2
288	Dzogbeshie Yevu	3B10c	0.48	1.2
	TOTAL			
	SECTION 3 BLOCK C			
289	Kwesivi Dunyo	C1	1.76	4.4
290	Danyeametor Kpogo	C2	1.76	4.4
291	Godwin Gborglah	C3a	1.32	3.3
292	Dodzi Lartey	C3	0.44	1.1
293	Rev G.K. Halogbe	C4a	0.44	1.1
294	John Ayeke	C4b	0.44	1.1
295	Kofitsey Akorli	C4c	0.88	2.2
296	Atoe Tegah	C5a	0.56	1.4
297	Agbodzi Sokpor	C5b	1.2	3
298	Kpeleshie Christian Awayevu	C6a	0.88	2.2
299	Comfort Awusah Yeluwor	C6b	0.88	2.2
300	Wonder Aborlor	C7a	0.88	2.2
301	Shittor Batsi	C7b	0.88	2.2
302	Ernest Kpodo	C8	1.76	4.4
303	Wise Olu Wemegah	C9a	0.88	2.2
304	Margaret Agozie	C9b	0.88	2.2
305	Zuru Norvitor Egblogbe	C10a	0.88	2.2
306	Emmanuel Funu	C10b	0.88	2.2
	TOTAL			
	SECTION 3 BLOCK D AND E			
307	Yaw Ahifodzi	3D1	1.96	4.9
308	Atsu Fiatsi	3D2	1.96	4.9
309	Eric Nanewortor	3D3a	0.96	2.4
310	Evelyn Dzotefe	3D3b	0.96	2.4
311	Wilson Ackey J. K.	D4	1.92	4.8
312	Emmanuel Klutse	D5a	0.96	2.4
313	Kwadzo Agbavitor	D5b	0.96	2.4
314	Midao Kwabla	D6	1.92	4.8
315	Sowada Aflah	D7	1.92	4.8
316	George A. Mikoku	D8	1.92	4.8
317	A. Nusenoo	D9a	0.88	2.2
318	Constant Amegbor	D9b	0.88	2.2
319	Kweku Gborglah	D10a	0.88	2.2
320	Richard F. Tadermey	D10b	0.88	2.2
	TOTAL			
321	Klutse Akogo	3E1.	1.48	3.7

322	Yonah Kwamesiani	3E2.	1.48	3.7
323	Datorwu Akogo	3E3.	1.48	3.7
324	Misheda Dogbe	E4	1.48	3.7
325	Famous Dotsey Fiati	E5	1.48	3.7
326	Yawo Gborglah	E6	1.48	3.7
327	Besa GBEBLEWU	E7a	1	2.5
328	Cephas Gbeblewu	E7b	0.48	1.2
329	Joseph Adelayitah	E8	1.48	3.7
330	Daniel Dzorkpe Gamenyah	E9	1.48	3.7
331	Mountain Yao Gbeblewu	E10	1.48	3.7
	TOTAL			
	SECTION 4 BLOCK A			
332	Frank Gagbene	4A1a	1	2.5
333	Dogbe Agbale	4A1b	0.5	1.25
334	Kafui Nyidevu	4A1c	0.5	1.25
335	Wonder Yeborwo	4A2a	1	2.5
336	Kofi Evadzi	4A2b	1	2.5
337	Mawuenyegah T. Agbale	4A3a	1	2.5
338	Kwaku Mawuena Adukpo	4A3b	1	2.5
339	Ben Atsu Datsomor	4A4a	0.4	1
340	Patience Nusenu	4A4b	0.4	1
341	Charles Ayekple	4A4c	0.4	1
342	John Gbordzor	4A4d	0.4	1
343	Kwadwo Agbale	4A4e	0.4	1
344	Woyeanawo Agbale	4A5a	0.68	1.7
345	Ami Agozie	4A5b	0.68	1.7
346	Famous Kpodo	4A5c	0.68	1.7
347	Saviour Adukpo	4A6a	0.68	1.7
348	Believer Awudi	4A6b	0.68	1.7
349	Kwame Avuworda	4A6c	0.68	1.7
350	Kwaku T. Dzaka	4A7a	1	2.5
351	Fogah Wisdom Ahiataku	4A7b	1	2.5
352	Mensah Ametordzi	4A8a	0.6	1.5
353	Wiiliam Kwaku Tsigbey	4A8d	0.4	1
354	Saviour Tsifotey	4A8b	0.6	1.5
355	Georgina Normeshi	4A8c	0.4	1
356	Kwaku Kpogo	4A9a	1.2	3
357	Kwadzovi Agbale	4A9b	0.8	2
358	Kwabla Ahordosu	4A10a	1	2.5
359	Happy Hlortsi	4A10b	1	2.5
	TOTAL			
	SECTION 4 BLOCK B			
360	Kordzo Fianu	4B1	1.76	4.4

361	Augustine Mawuli Zameti	4B2a	0.88	2.2
362	Juliana Ayie	4B2b	0.88	2.2
363	Emmanuel Mensah	4B3a	0.88	2.2
364	Ablavi Nutorwoli	4B3b	0.44	1.1
365	Dadolo Alaga	4B3c	0.44	1.1
366	Midao Agbanyo	4B4a	0.88	2.2
367	Dora Gbeblewu	4B4b	0.44	1.1
368	Gladstone Gbeblewu	4B4c	0.44	1.1
369	Joshua Nuworkpor	4B5a	0.88	2.2
370	Wisdom Zorkpo	4B5b	0.88	2.2
371	Adzo Dzorka	4B6a	0.88	2.2
372	Mansah Sokpotonu	4B6b	0.44	1.1
373	Kwashie Gbordzor	4B6c	0.44	1.1
374	Ganyorme Agbali Sogah	4B7a	0.88	2.2
375	John Awaga	4B7b	0.88	2.2
376	Comfort Dogbey	4B8a	0.44	1.1
377	Mary Kwasiwor Dogbey	4B8b	0.44	1.1
378	Midawo Fialesegbor	4B8c	0.44	1.1
379	Akakpo Aglonu	4B9a	0.88	2.2
380	Mensah D. Aheto	4B9b	0.88	2.2
381	Moses Adelayita	4B10a	0.44	1.1
382	Christian Adelayita	4B10b	0.44	1.1
383	Samuel Atsu Azuma	4B10d	0.44	1.1
384	Kudzo Adelayita	4B10c	0.44	1.1
	TOTAL			
	SECTION 4 BLOCK C			
385	Kwashivi Ahiable	4C1a	0.88	2.2
386	Kwakuvi Akogo	4C1b	0.88	2.2
387	Ehi Atsufi Amua	4C2a	0.88	2.2
388	Godwin Amuah	4C2b	0.88	2.2
389	Felix Deku	4C3a	0.44	1.1
390	Hudzengor Amuah	4C3b	0.44	1.1
391	Kwadwo Sedoh	4C3c	0.88	2.2
392	Kwashie Gborgla	4C4a	0.88	2.2
393	Chris Gbeblewu	4C4b	0.44	1.1
394	Patience Edzorxoxo	4C4c	0.44	1.1
395	Kwaku Agozie	4C5a	0.44	1.1
396	Felix Amedzeafe	4C5b	0.44	1.1
397	Ami Kpogo	4C5c	0.44	1.1
398	Yawo Fiase	4C5d	0.44	1.1
399	Moses Amewuga Gborglah	4C6a	0.88	2.2
400	Emmanuel Gbadegbe	4C6b	0.88	2.2
401	Agbey Ameedzefe	4C7a	0.88	2.2

402	Mawuli Atidoglo	4C7b	0.88	2.2
403	Yao Johnson Fiamordzi	4C8a	0.44	1.1
404	Vivian Mawusi Kutokpor	4C8b	0.44	1.1
405	Joseph Ahiable	4C8c	0.88	2.2
406	Kofi Amegah	4C9a	0.44	1.1
407	Gbedema E. K. Dormenyo	4C9b	0.44	1.1
408	Samuel K. Avueke	4C9c	0.88	2.2
409	Simon K. Adelayita	4C10a	0.88	2.2
410	Christian Kutokpor	4C10b	0.88	2.2
	TOTAL			
	SECTION 4 BLOCK D			
411	Hope Huze	4D1	1.76	4.4
412	Gideon Kutokpor	4D2a	0.44	1.1
413	Afi Wordi	4D2b	0.44	1.1
414	Godwin Akorta	4D2c	0.88	2.2
415	Amegayibor Havor Dovi	4D3a	0.88	2.2
416	Celestine Agbeko	4D3b	0.88	2.2
417	Francis Agbagba	4D4b	0.44	1.1
418	Kwabla Kpodo	4D4a	1.32	3.3
419	Prosper E. Gbeblewu	4D5a	0.44	1.1
420	Gideon Agbodza	4D5b	0.44	1.1
421	Hellen Agbanyo	4D5c	0.44	1.1
422	Esinam Flovi	4D5d	0.44	1.1
423	Agbodzi Ahianyo	4D6a	0.88	2.2
424	Kwabla Yegbe	4D6b	0.88	2.2
425	Dovi Alakpa	4D7a	0.44	1.1
426	Anthony Gbeblewu	4D7b	0.44	1.1
427	Joseph Kwabla Kutokpor	4D7c	0.44	1.1
428	Fofo Wordi	4D7d	0.44	1.1
429	Doe Akogo	4D8a	0.88	2.2
430	Ami Kpogo	4D8b	0.44	1.1
431	Kwabla Sedofia	4D8c	0.44	1.1
432	Augustine Nanewortor	4D9a	0.44	1.1
433	Kassah Atitso	4D9b	0.44	1.1
434	Yaovi Hukportsi	4D9c	0.44	1.1
435	Yawovi Gladys Ahiaku	4D9d	0.44	1.1
436	Kwame Amuah	4D10	1.76	4.4
	TOTAL			
	SECTION 4 BLOCK E			
437	Anthony Trorgbor	4E1a	0.48	1.2
438	Timothy Dorgbetor	4E1b	0.48	1.2
439	Morgan Kofi Wordi	4E1c	0.48	1.2
440	Dangoe Dorvlovi	4E2a	0.68	1.7

441	Ama Adevu	4E2b	0.68	1.7
442	Doehill Gbeblewu	4E3a	0.84	2.1
443	DoeHill Gbeblewu	4E3b	0.4	1
444	Agbota Dodzi Dorgbetor	4E4.	1	2.5
445	George Vondoli	4E5.	1	2.5
446	Francis Nanewortor	4E6.	1	2.5
447	Doegah Amuah	4E7a	0.48	1.2
448	Petro K. Gbeblewu	4E7b	0.48	1.2
449	Aklufui Beauty Adzibolo	4E8a	0.4	1
450	Christopher Kofigah	4E8b	0.4	1
451	Ruben Kofi Tsifotey	4E9.	0.48	1.2
452	Ruben Kofi Tsifotey	4E10.	0.48	1.2
	TOTAL			
	SECTION 5 BLOCK A			
453	Gameli Kpordugbe	5A1a	0.4	1
454	Pearl Tepeali	5A1b	0.8	2
455	Francis Tepeali	5A1c	0.8	2
456	Dadofu Hukportsi	5A2a	0.4	1
457	Victor Nefui	5A2b	0.4	1
458	Robert Yao Fianu	5A2c	0.6	1.5
459	Comfort Klufui Gamenyah	A2d	0.6	1.5
460	Millicent Birigor	A3a	0.8	2
461	Veronica Dey	A3c	0.4	1
462	Minao Miatsiazi	A3d	0.8	2
463	Etse Fianu	A4a	0.8	2
464	Kumah Tsifote	A4b	0.4	1
465	Kwadzo Petehene Avorkpo	A4c	0.8	2
466	Florence Atinyo	5A5a	0.4	1
467	Eva Amedume	5A5b	0.8	2
468	George Axorlu	5A5c	0.8	2
469	Dotsey Hlortsi	A6a	0.8	2
470	Mami DZOKOTO	A6b	0.4	1
471	Sowoada Tsipote	A6c	0.8	2
472	Fiavor George	A7a	0.4	1
473	Comfort Fianu	A7b1	0.4	1
474	31st Dec. Women Klenormasi	A7b2	0.4	1
475	Nicholas Gamor	A7c	0.8	2
476	Ayivor Adugba	A8a	0.5	1.25
477	Gabriel Kwadzotse Nusenu	A8b	1.5	3.75
478	Josephine Gbafah	A9a	0.4	1
479	Ama GBAFA	A9b	0.8	2
480	Korsi Azumah	A9c	0.8	2
481	Doris Ahiabor	A10a	0.8	2

482	Simon K. Ayador	A10b	0.4	1
483	Dawuso Hanu	A10c	0.4	1
484	Amuzu Amegatsey	A10d	0.4	1
	TOTAL			
	SECTION 5 BLOCK B			
485	Kormi Edward Hunorvi	5B1a	0.4	1
486	Robert Nefui	5B1b	0.4	1
487	Geofrey Gbadah	5B1c	0.8	2
488	David Azinu	5B2a	0.8	2
489	David Agbodzi	B2c	0.4	1
490	Felix Kwame Awuku	B2d	0.4	1
491	John Ahiagble	B3a	0.4	1
492	Eklu Nusenu	B3b	0.4	1
493	Klevor Gbafah	B3c	0.8	2
494	Maana Dusey	B4a	0.8	2
495	Emmanuel Afawubo Xetayibor	B4b	0.4	1
496	Pamela Dawusorde ATITSOGBUI	B4c	0.4	1
497	Victoria Funu	B5a	0.8	2
498	Thomas Birigor	B5b	0.4	1
499	Gladys BIRIGOR	B5c	0.4	1
500	Ben Agbefu	5B6a	0.8	2
501	Gameli Kpordugbe	5B6b	0.8	2
502	Midao Sanefu	5B7a	0.8	2
503	Martin Amedzeafe	B7b	0.8	2
504	Mary Kunakie	B8a	0.4	1
505	Yaa Sallah	B8b	1.2	3
506	kwadzo Agozie	B9a	0.8	2
507	Nutego Kwashie	B9b	0.8	2
508	William Gbafa	B10	1.6	4
	TOTAL			
	SECTION 5 BLOCK C			
509	Sofeda Tsifote	5C1a	0.8	2
510	Dadofu Hukportsi	5C1b	0.8	2
511	Happy Nefui-Agozie	5C2a	0.8	2
512	Doe Wemegah	C2b	0.8	2
513	Mensah Gokah	C3a	0.8	2
514	Believer SOGBE	C3b	0.4	1
515	Dofui Kofitsey	C3c	0.4	1
516	Gameli Tsifote	C4a	0.8	2
517	John Awuku	C4b	0.8	2
518	Kwashie Awuku	C5a	0.8	2
519	John Ahiagble	C5b	0.8	2
520	Amuzu Tsifote	C6a	0.8	2

521	Atoie Hukportsi	C6b	0.8	2
522	Kwashie Funu	C7a	0.8	2
523	Christopher Borlor	C7b	0.8	2
524	Mawutor Dzotepe	C8a	0.8	2
525	Felix Tsifote	C8b	0.8	2
526	Seth Gamor	C9a	0.8	2
527	Midao Nefui	C9b	0.8	2
528	Thomas Gbadah	C10a	0.8	2
529	Etse Fianu	C10b	0.8	2
	TOTAL			
	SECTION 5 BLOCK D			
530	Kwadzo Gbordzor	5D1a	0.8	2
531	Agbodzi Tsipotey	5D1b	0.8	2
532	Adzo Kpogo	5D1c	0.4	1
533	Lebene Ametepe	5D2a	0.8	2
534	Kwadwo Ametepui	5D2b	0.8	2
535	Aku Deku	D2c	0.4	1
536	George Dzikuna	D3a	0.8	2
537	Amuzu James Azemah	D3b	0.4	1
538	Senam AGBALENYO	D3c	0.4	1
539	Richard Ahiankui	D4a	0.8	2
540	Sosu Tsipotey	D4b	0.8	2
541	Kwashie Agbayiza	D5a	0.6	1.5
542	Dzakpa Agbalenyo	D5b	0.6	1.5
543	Dangoe Dzotefe	D6	1.2	3
544	Francis Tepearli	D7a	0.4	1
545	Gago Gokah	D7b	0.8	2
546	Felix Kwame Awuku	D8	1.2	3
547	Christian Pesewa Ahiankui	D9	1.2	3
548	Gifty KUDOTO	D10a	0.8	2
549	Wonder KUDOTO	D10b	0.4	1
	TOTAL			
	SECTION 6 BLOCK A			
550	Kwaku Nusenu	6A1a	1.12	2.8
551	Samuel Agbetsiafa	6aA1b	0.56	1.4
552	Klu Setsoafia	6A1c	0.56	1.4
553	Dangoe Sogbey	6A2a	1.12	2.8
554	Dameizor Wemegah	6A2b	1.12	2.8
555	Lawrence Vedanu	6A3a	0.48	1.2
556	Daniel Adzomani	6A3b	1.76	4.4
557	Israel Monyo	6A4a	0.48	1.2
558	Emmanuel K. Nanenu	6A4b	0.68	1.7
559	Samuel Akoto	6A4c	1.12	2.8

560	Kwaku Nyideu	6A5a	1.12	2.8
561	Gbeda Kunakie	6A5b	1.12	2.8
562	Efui Ganavudo	6A6b	0.56	1.4
563	Dovi Hlortsi	6A6a	0.56	1.4
564	Alice Tega Kunakie	6A6c	1.12	2.8
565	Kennedy Dzikunu	6A7a	1.12	2.8
566	George Akoto	6A7b	1.12	2.8
567	Martin Damali	6A8a	0.92	2.3
568	Yormaxle AHLE	6A8b	0.4	1
569	Sefakor Tettegah	6A8c	0.92	2.3
570	Thomas Q. Fianu	6A9a	1.12	2.8
571	Raymond Ben Kofi Fianu	6A9b	1.12	2.8
572	Torgbui Gbordzor VII	6A10a	0.48	1.2
573	Kwadwo Torkpo	6A10b	1.76	4.4
	SECTION 6 BLOCK B			
574	Agozie George	6B1a	0.94	2.35
575	Dzigbordi Amegah	6B1b	0.94	2.35
576	Celestine Abla Tsifotey	6B2a	0.94	2.35
577	Lisa Akoto	6B2b	0.94	2.35
578	Churchill Adzomani	6B3a	0.94	2.35
579	Wisdom Kwashie Gbeti	6B3b	0.94	2.35
580	Martin Wometse	6B4a	0.94	2.35
581	Fidelia Dogbe	6B4b	0.94	2.35
582	Mawuli Xodanu	6B5a	0.94	2.35
583	Gbeda Nyadzi	6B5b	0.94	2.35
584	S.K. Kwaku	6B6a	0.4	1
585	Dawolo Dagadu	6B6b	0.4	1
586	Ps. Daniel Akuamoah Boateng	6B6c	0.68	1.7
587	Kofi Payedwenie	6B07	1.88	4.7
588	Richard Kpevor	6B8a	0.47	1.18
589	Veronica Dussey	6B8b	0.47	1.18
590	Ametepui Sanefu	6B8c	0.47	1.18
591	Emmanuel Dagbah	6B8d	0.47	1.18
592	Wisdom Yao Baku	6B9	1.88	4.7
593	Dora Avor	6B10b	0.94	2.35
594	Christian Kwadzo Agozie	6B10a	0.94	2.35
	SECTION 6 BLOCK C			
595	Kwadwo Wometse	6C1	1.88	4.7
596	Torgbui Zormelo	6C2a	0.48	1.2
597	Kwaku Datsomor	6C2b	0.48	1.2
598	Singer Sebuabe	6C2c	0.94	2.35
599	Akutor Aglonoo	6C3a	0.94	2.35
600	Salomey Wometse	6C3b	0.94	2.35

601	Benjamin Koshie Kpodo	6C4	1.88	4.7
602	Albert Osabutey	6C5	1.88	4.7
603	Sotorwogbe Atsu	6C6a	0.94	2.35
604	Amuzu Nyidevu	6C6b	0.94	2.35
605	Nueli Attipoe	6C7	1.88	4.7
606	Geofrey Attipoe	6C8a	0.94	2.35
607	Stanley E. Ghamli	6C8b	0.94	2.35
608	Kwawu Akoto	6C9a	0.94	2.35
609	Torsu Mercy	6C9b	0.94	2.35
610	Esther Takpa	6C10a	0.94	2.35
611	Kwasiwor Zevor	6C10b	0.94	2.35
	SECTION 6 BLOCK D			
612	Benjamin Tay Alorbu	6D1	1.32	3.3
613	Abraham Ashiabi	6D2	1.32	3.3
614	Azorshi Agbedoe	6D3a	0.66	1.65
615	Dofui Atsu	6D3b	0.66	1.65
616	Philip K. Hanu	6D4	1.32	3.3
617	Michael Dagba	6D5	1.32	3.3
618	Etse Gbeve	6D6	1.32	3.3
619	Kwashie Ahiakpa	6D7	1.32	3.3
620	Sylvestor Agbeko	6D8	1.32	3.3
621	Richard Monyo	6D9	1.32	3.3
622	Grace Agozie Gbafa	6D10	1.32	3.3
	TOTAL			
	SECTION 7 BLOCK A			
623	Kodzo Agbogli Botri	7A1b	0.5	1.25
624	Doris Avowor	7A1b	0.5	1.25
625	Raphael Akpor Nefui	7A1c	1	2.5
626	Sylvanus Gartey	7A2a	1	2.5
627	Manyo Kunaki	7A2b	1	2.5
628	Kwaku Klutse	7A3a	1	2.5
629	John Awuku	7A3b	1	2.5
630	Francis Gugodo	7A4a	0.4	1
631	Seth Galley	7A4b	1.6	4
632	Kodzo Kugblenu	7A5a	1	2.5
633	Yao Fiamegbe	7A5b	1	2.5
634	Christopher Kwami Adzibolo	7A6a	0.4	1
635	Rebecca Mornyuie	7A6b	1.6	4
636	Samuel Berkoe	7A7a	1	2.5
637	Daniel Gyan	7A7b	1	2.5
638	Seth Adzibolo	7A8a	1	2.5
639	Henry Adzibolo	7A8b	1	2.5
640	Kwashie Yevu	7A9a	1	2.5

641	Attitsogbui Pomevor	7A9b	1	2.5
642	Justice Aho	7A10a	0.3	0.75
643	Mawuko Amekuedi	7A10b	1.2	3
644	Edem Amekuedi	7A10c	0.4	1
	TOTAL			
	SECTION 7 BLOCK B			
645	Christian Dagbah	7B1a	0.44	1.1
646	Yohanes Fiagah	7B1b	0.44	1.1
647	Mansa Deku	7B1c	0.44	1.1
648	Felix Nefui	7B1d	0.44	1.1
649	Gameli Adzomani Tordzagbo	7B2a	0.88	2.2
650	Nani Adzomani	7B2b	0.88	2.2
651	Midawo Egu	7B3a	0.44	1.1
652	Torgbui Soshi	7B3b	0.44	1.1
653	Simon Ahiataku	7B3c	0.44	1.1
654	Kwami Duho	7B3d	0.44	1.1
655	Gershon Danyo	7B4a	0.44	1.1
656	Mary Fiamegbe	7B4b	0.44	1.1
657	Adugba Teku	7B4c	0.44	1.1
658	Wonder Sogbey	7B4d	0.44	1.1
659	Ama Akrobotu	7B5a	0.88	2.2
660	Kekeme Agbeforbu	7B5b	0.88	2.2
661	Atsu KUTORWU	7B6a	0.88	2.2
662	Moses AZUMAH	7B6b	0.88	2.2
663	IDA STAFF Seth Dzokoto	7B7	1.76	4.4
664	Stephen Mishio	7B8a	0.88	2.2
665	Lorsohu Apedo	7B8b	0.88	2.2
666	James Mawuena Agbeshi	7B9a	0.44	1.1
667	Kekeme Kporkporvi	7B9b	0.44	1.1
668	Albert DZIKUNU	7B9c	0.44	1.1
669	Sampson Amegatsey	7B9d	0.44	1.1
670	Kokui Azuma	7B10a	0.44	1.1
671	Christie Lawson	7B10b	0.88	2.2
672	Grace Sallah	7B10c	0.44	1.1
	TOTAL			
	SECTION 7 BLOCK C			
673	Kwodzo Tettey	7C1a	0.44	1.1
674	Leonard Tetteh	7C1b	1.32	3.3
675	Soenyametor Akroboto	7C2	1.76	4.4
676	C.K. Birigor	7C3a	0.88	2.2
677	Mary Babanawo	7C3b	0.88	2.2
678	Samuel AKPAH	7C4a	0.88	2.2
679	Dadziezor Edor	7C4b	0.88	2.2

680	Believer Sogbey	7C5a	0.44	1.1
681	Leonard Sogbey	7C5b	0.44	1.1
682	Adugba Yevu	7C5c	0.88	2.2
683	Caesar Avorgah	7C6	1.76	4.4
684	Alice Amegatsey	7C7a	0.88	2.2
685	Simon Klutse	7C7b	0.88	2.2
686	Faustina Mawusi Hlortsi	7C8a	0.88	2.2
687	Kwaku Segbenu	7C8b	0.88	2.2
688	Ablah Kpodo	7C9a	0.44	1.1
689	Evelyn Atsufui Deku	7C9b	0.44	1.1
690	C.K. Noah Avorkliya	7C9c	0.88	2.2
691	Michael Kabutey Doe	7C10	1.76	4.4
	TOTAL			
	SECTION 7 BLOCK D			
692	Festus Kwasi Babanawo	7D1a	0.44	1.1
693	Abla Kpodovia	7D1b	0.44	1.1
694	Felix Funu	7D1c	0.44	1.1
695	Francis Nefui	7D2a	0.44	1.1
696	Anne Gawu	7D2b	0.44	1.1
697	Dangoe Atsikpa Dem	7D2c	0.44	1.1
698	Gabriel Babanawo	7D3	1.32	3.3
699	Yawo Amegatsy	7D4	1.32	3.3
700	Henry Adzibolo	7D5a	0.66	1.65
701	Seth Adzibolo	7D5b	0.66	1.65
702	Bessa Pomevor	7D6a	0.44	1.1
703	Eklu Pomevor	7D6b	0.44	1.1
704	Atitsogbui Pomevor	7D6c	0.44	1.1
705	Festus Kwasi Babanawo	7D7	1.32	3.3
706	Hope Soka	7D8	1.32	3.3
707	Wonder Pomevor	7D9	1.32	3.3
708	Kate Agbanyo	7D10	1.32	3.3
	TOTAL			
	SECTION 8 BLOCK A			
709	David Ashiagbor	8A1a	0.96	2.4
710	Torgbui Ashiagbor	8A1b	0.96	2.4
711	Philip Hlortsi	8A2	0.96	2.4
712	Mark Hlortsi	8A2b	0.96	2.4
713	Torkorsu Sallah	8A3a	0.96	2.4
714	Emmanuel Kofi ADONU	A3b	0.48	1.2
715	Wisdom Ashiagbor	A3c	0.48	1.2
716	Koshie Aku Amegatsey	A4a	0.48	1.2
717	Andrews Adzisu	A4b	0.48	1.2
718	Torgbui Sedzro	A4c	0.96	2.4

719	IDA STAFF (DJABA)	A5a	0.96	2.4
720	Robert O. Mensah	A5b	0.96	2.4
721	IDA STAFF (BIGGA)	A6a	1.02	2.55
722	IDA STAFF	A6b	0.48	1.2
723	IDA STAFF (VORDIGBE)	A6c	0.42	1.05
724	Dabasu Galley	A7	1.92	4.8
725	Yaa Serwah Nana	A8a	0.96	2.4
726	Aku Adzisu	A8b	0.48	1.2
727	Kwame Nelson Amegatsey	A8c	0.48	1.2
728	Dzogbeshi Galley	A9	1.76	4.4
729	Patience Gameti	A10a	0.88	2.2
730	Ami Parama	A10b	0.88	2.2
	TOTAL			
	SECTION 8 BLOCK B			
731	Ekpe Ametepe	8B1a	0.88	2.2
732	Horsode Bedzra	8B1b	0.88	2.2
733	Joseph K. Amedeka	8B2	1.76	4.4
734	Stephen Kroh	8B3a	0.88	2.2
735	Mensah Awuku	B3b	0.88	2.2
736	David Hlortsi	B4a	0.88	2.2
737	Solomon Hlortsi	B4b	0.88	2.2
738	Daniel N. Amenyaglo	B5a	0.88	2.2
739	Enyonam Wemegah	B5b	0.88	2.2
740	Christine Hodanu	B6a	0.88	2.2
741	Rebecca Galley	B6b	0.88	2.2
742	Gilbert Edzorho	B7a	0.44	1.1
743	Eduriam Edzorho	B7b	0.44	1.1
744	Samuel Edzorho	B7c	0.88	2.2
745	Veronica Avusuglo	B8a	0.88	2.2
746	Nani Gbeti	B8b	0.88	2.2
747	Atsu Adonu	B9a	1.32	3.3
748	Kwami Anyigba	B9b	0.44	1.1
749	Rose Kplorla Kuzagbe	B10a	0.88	2.2
750	Martin Amedzeafe	B10b	0.44	1.1
751	L. K. Ahiataku	B10c	0.44	1.1
	TOTAL			
	SECTION 8 BLOCK C			
752	David Datsomor	8C1a	0.88	2.2
753	Romeo Adzisu	8C1b	0.88	2.2
754	McClean K. HEHEATROR	8C2a	0.88	2.2
755	Vincent Mensah	C2b	0.88	2.2
756	Emmanuel Kwadzo Boateng	C3a	1.28	3.2
757	Kwame Adetu	C3b	0.44	1.1

758	Margret Mawuena Adukpo	C4a	0.92	2.3
759	Jonathan Kudolo	C4b	0.92	2.3
760	Lucky Dogbeyvia	C5a	0.92	2.3
761	Philip Dogbe	C5b	0.92	2.3
762	Wonder Akagla	C6a	0.92	2.3
763	Belinda Niboh	C6b	0.92	2.3
764	Seth Solagah	C7a	0.92	2.3
765	Edward Kudese	C7b	0.92	2.3
766	Kwashiwor Gawugah	C8a	0.92	2.3
767	Jacob Matsi	C8b	0.92	2.3
768	Kwaku Babanawo	C9	1.84	4.6
769	Celestine Dorkitey	C10a	0.92	2.3
770	Joyce Tornyi	C10b	0.92	2.3
	TOTAL			
	SECTION 8 BLOCK D			
771	Kwame Adetu	D1a	0.44	1.1
772	Dangoe Senafu	D1b	1.32	3.3
773	Kennedy Babanawo	D2a	0.44	1.1
774	Atsu Paramah	D2b	0.44	1.1
775	Emmanuel Domi	D2c	0.44	1.1
776	Vincent Kofi Missigah	D2d	0.44	1.1
777	Gershon Yevu	D3a	0.44	1.1
778	Beauty Etse Kuenyehia	D3b	0.44	1.1
779	Clemence Ahiataku	D3c	0.88	2.2
780	Paramah Dzakpa	D4a	0.88	2.2
781	Wisdom Atokple	D4b	0.88	2.2
782	Minao Kpodo	D5a	0.44	1.1
783	Bessah AGBOGAH	D5b	0.44	1.1
784	Joshua Nuworkpor	D5c	0.88	2.2
785	Kodzo Zigah	D6a	0.88	2.2
786	Bessah Agbogah	D6b	0.88	2.2
787	Yao Domi	D7a	0.88	2.2
788	Doris Homayor Agbogah	D7b	0.88	2.2
789	Rubben Babanawo	D8	1.26	3.15
790	Vida Ahiable	D9a	0.44	1.1
791	Dzatugbui Tsagli	D9b	0.44	1.1
792	Francis Yao Agbokemey	D9c	0.88	2.2
793	Lucky Datsomor	D10a	0.92	2.3
794	George Akakpo Afedo	D10b	0.92	2.3
	TOTAL			
NO	**SECTION 9 A BLOCK**			
795	IDA Demonstration	A1	1.68	4.2
796	Daniel Dogbey	A2a	0.84	2.1

797	Vitus Nanenu	A2b	0.84	2.1
798	Beinu Aworyekpor	A3a	0.84	2.1
799	Ablorshie Setsoafia	A3b	0.42	1.05
800	Yawo Heavy Hotorwoshie	A3c	0.42	1.05
801	George Frederick Yegbe	A4a	0.84	2.1
802	Hudzengor Dorgbedevor	A4b	0.84	2.1
803	Alex Agbey Gaku	A5a	0.84	2.1
804	Josephine Akpah	A5b	0.84	2.1
805	Eric Avevor	A6a	0.84	2.1
806	John Avevor	A6b	0.84	2.1
807	IDA STAFF (BERNARD)	A7a	0.84	2.1
808	Victoria Kpotorsu	A7b	0.84	2.1
809	P. K Mawuena	A8a	1.2	3
810	Anna Amuzu	A8b	0.44	1.1
811	IDA STAFF (ASSIFUAH)	A9a	0.84	2.1
812	Gideon Kwabla Kokoroko	A9b	0.84	2.1
813	Yao Atobrah	A10a	0.84	2.1
814	Richard Bedzrah	A10b	0.4	1
815	Tetteh Sowugah	A10c	0.4	1
	TOTALS			
	SECTION 9 B BLOCK			
816	Armstrong Hotorwoshie	B1a	0.88	2.2
817	Afi Agozie	B1b	0.88	2.2
818	Peace Odzor	B2a	0.44	1.1
819	Torgbui Ashiagbor	B2b	0.6	1.5
820	David Ashiagbor	B2c	0.6	1.5
821	Nani Hanu	B3a	0.84	2.1
822	Anthony Grunisky Hlortsi	B3b	0.84	2.1
823	Godwin Sogbey	B4a	0.84	2.1
824	Felicia Ametefe	B4b	0.84	2.1
825	Andrews Adzisu	B5a	0.84	2.1
826	Godwin Sogbey	B5b	0.84	2.1
827	IDA STAFF	B6	1.68	4.2
828	Johnson Amedume	B7a	0.84	2.1
829	Gladys Akpah	B7b	0.84	2.1
830	Stephen Kroh	B8a	0.84	2.1
831	David Dagadu	B8b	0.84	2.1
832	Horsodey Babanawo	B9a	0.84	2.1
833	Grace Gbekle	B9b	0.42	1
834	Alice Yakor Ayayi	B9c	0.42	1
835	Shepherd Berry	B10a	0.84	2.1
836	Sakyiwa Asare Yegbe	B10b	0.84	2.1
	TOTAL			

	SECTION 9 C BLOCK			
837	Godwin Amedeka	C1a	0.88	2.2
838	Seth Mibieku	C1b	0.88	2.2
839	Gabriel Kwaku Attipoe	C2a	0.88	2.2
840	Josephine Dzikunu	C2b	0.88	2.2
841	James Afagbedzi ASRAVOR	C3a	0.88	2.2
842	Veronica Amedeka	C3b	0.88	2.2
843	Lena Adadey	C4a	0.88	2.2
844	Aku Sosu	C4b	0.88	2.2
845	Christiana Yawuli Awumey	C5a	0.88	2.2
846	Annas Michael Halm	C5b	0.88	2.2
847	Torgbui Tetekpah II	C6a	0.88	2.2
848	Josephine Ahiakpah	C6b	0.44	1.1
849	Wisdom Kwame Gbetsi	C6c	0.44	1.1
850	Logosu Dagbui	C7	1.76	4.4
851	Midao Agoha	C8a	0.88	2.2
852	Atsu Agoha	C8b	0.88	2.2
853	Emmanuel Niboh	C9a	0.88	2.2
854	Evelyn Atitsogbui	C9b	0.88	2.2
855	Koshie Galley	C10a	0.88	2.2
856	Jacob W. K. Tawiah	C10b	0.88	2.2
	TOTAL			
	SECTION 9 D BLOCK			
857	William Kwami Adade	D1a	1	2.5
858	Michael BEDZRA	D1b	0.48	1.2
859	Aborgeh Akpalu	D1c	0.48	1.2
860	Esi Agbogah	D2a	0.9	2.25
861	Dovi Sewornu	D2b	0.9	2.25
862	Rejoyce Agbeforbu	D3a	0.9	2.25
863	Sampson Dotsey Agbenu	D3b	0.9	2.25
864	Godson Takpaze	D4	1.8	4.5
865	Amos Deku	D5	1.9	4.75
866	Emmanuel Agozie	D6a	0.96	2.4
867	Kekeme Agbeforbu	D6b	1	2.4
868	Vincent Baah	D7a	1	2.5
869	Emmanuel Sowada	D7b	1	2.5
870	Lydia Fiagbatsi	D8a	0.84	2.1
871	Midao Egeh	D8b	1.2	3
872	Rose Fiadzinu	D9a	1.12	2.8
873	Emmanuel Domi	D9b	0.56	1.4
874	Torgbui Adela Katsawe	D9c	0.56	1.4
875	Evelyn Klokpodzi	D10a	1.1	2.75
876	Wilson Sarbah	D10b	1.1	2.75

	TOTAL			
NO	SECTION 10 A BLOCK			
877	Aku Galley	A1a	0.4	1
878	Rapheal Amegayibor	A1b	0.4	1
879	Lumor Agbeforbu	A1c	0.4	1
880	Jacob Ametefe	A1d	0.4	1
881	Ebenezer VIDZA	A2a	0.4	1
882	William Adade	A2b	0.4	1
883	Kwashie Gawugah	A2c	0.4	1
884	Amuzu Gbedzawu	A2d	0.4	1
885	Francis Dagadu	A3a	0.8	2
886	Theophilus Agozie	A3b	0.4	1
887	Paul Babanawo	A3c	0.4	1
888	Ama Amedume	A4a	0.8	2
889	Gbeda N. Sogbey	A4b	0.4	1
890	Gbeda Nuvi Agbanyu	A4c	0.4	1
891	Awushie Agbogah	A5a	0.4	1
892	Yao Wisdom Lumor	A5b	0.4	1
893	Charles Ahordzo	A5c	0.4	1
894	Lucia Domi	A5d	0.4	1
895	Hunyeametor Klutse	A6a	0.8	2
896	Philip Kwashi Daku	A6b	0.4	1
897	Akakpo Wuakpo	A6c	0.4	1
898	Emmanuel Amenuku	A7a	0.8	2
899	Aku Agbagidi	A7b	0.8	2
900	Johnson Bokloe	A8a	0.4	1
901	Derick Johanes Asafo	A8b	0.4	1
902	Gladstone Bluawofogbe	A8c	0.4	1
903	Emmanuel Kofi Avettey	A8d	0.4	1
904	Daniel Amenyaglo	A9a	0.8	2
905	Isaac Kodzie	A9b	0.4	1
906	Henry Kwashie	A9c	0.4	1
907	Victoria Shittor	A10a	0.8	2
908	Amuzu Flovi	A10b	0.4	1
909	Agathar Etse	A10c	0.4	1
	SECTION 10 B BLOCK			
910	Franklyn Amegatsey	B1	1.76	4.4
911	Kwadzo Senyo	B2a	0.8	2
912	Lucky Datsomor	B2b	0.8	2
913	Rose Wonuakor	B3a	0.8	2
914	Happy Adjei	B3b	0.8	2
915	Kwabla Gabin Ashiakpor	B4a	0.8	2
916	Ben Klinogo	B4b	0.8	2

917	Kwaku Ekpe	B5a	0.4	1
918	James Anyornu	B5b	0.4	1
919	Godwin Kwaku Addom	B5c	0.4	1
920	Yao Abonge	B5d	0.4	1
921	Doe Agozi	B6a	0.4	1
922	Mensah Fiagah	B6b	0.4	1
923	Kwadzovi Anyidoho	B6c	0.8	2
924	Ami Awudi	B7a	0.8	2
925	Godwin Atokple	B7b	0.8	2
926	Mawunyo KPORNYO	B8a	0.8	2
927	Yaovi Gbormittah	B8b	0.8	2
928	Kwakutse Tamakloe	B9	1.76	4.4
929	St. Anthony R.C Church Avalavi	B10a	0.8	2
930	Comfort Ashiakpor	B10b	0.4	1
931	Christian Ashiakpor	B10c	0.4	1
	TOTAL			
NO	**SECTION 10 C BLOCK**			
932	Eklu Gamenya	C1a	0.8	2
933	Mathias Sogbey	C1b	0.8	2
934	Cecilia Sovor	C2a	0.8	2
935	Wisdom Wetsi	C2b	0.4	1
936	Kofi Ahor	C2c	0.4	1
937	Godson Klokpodzi	C3a	0.8	2
938	Kwabla Azaglo	C3b	0.4	1
939	Minua Dovi	C3c	0.4	1
940	Lawrence Ahiataku	C4a	0.4	1
941	Rose Wonuakor	C4b	0.4	1
942	Ebenezer Afedo Sadam	C4c	0.4	1
943	Simon Amuah	C4d	0.4	1
944	Kwabla Glavlo	C5a	0.8	2
945	Michael Amedeka	C5b	0.8	2
946	David Ametefe	C6a	0.8	2
947	Exi Dormenyo	C6b	0.8	2
948	Francis Amuzu	C7	1.76	4.4
949	Dadolo Moses	C8a	0.8	2
950	Mercy Akpor	C8b	0.8	2
951	Esther Ahiawu (Akpabey)	C9a	0.8	2
952	Ama Salomey Hanu	C9b	0.8	2
953	Abla Agbeforbu	C10a	0.8	2
954	Favour Birigor	C10b	0.8	2
955	Ebenezer Amuzu Segbefia	10C5A	0.4	1
	TOTAL			
	SECTION 10 D BLOCK			

956	Eric Glate	D1a	1.16	2.9
957	Torbi Hadzitsey	D1b	0.4	1
958	Doe Simon Flovi	D1c	0.4	1
959	Saviour Adzorlolo	D2a	0.8	2
960	Juliana Agbanavor	D2b	0.4	1
961	Torgbui Akuna Fietsu	D2c	0.4	1
962	George Atitsogbui	D2d	0.4	1
963	Dotse Sogbey	D2e	0.4	1
964	Yao Wonuakor	D3a	0.8	2
965	Godwin Dogbatsey	D3b	0.4	1
966	Daniel Yevu Davor	D3c	0.4	1
967	Midao Kudoto	D3d	0.8	2
968	Hanson Xede Datsomor	D4a	0.8	2
969	Kwabla Sogbey	D4b	0.8	2
970	Seth Davor	D4c	0.4	1
971	Dadziezor Davor	D4d	0.4	1
972	Richard Odzor	D5a	0.8	2
973	William Borkloe	D5b	0.8	2
974	Sampson Asafo	D5c	0.8	2
975	Clemence Adzrakpanya	D6a	0.8	2
976	Kwashie Dordowe	D6b	0.8	2
977	Afi Nyuiewolona	D6c	0.4	1
978	Anthony Nyuiewolona	D6d	0.4	1
979	Vincent Yao Gankui	D7a	0.8	2
980	Regina Gateh	D7b	0.8	2
981	Torgbui Sorkpor III	D7c	0.8	2
982	Sylvia Adjei	D8a	1.2	3
983	Vida Gasu	D8b	0.8	2
984	Kwami Abofla	D8c	0.4	1
985	Yao Fietsu	D9a	0.4	1
986	Tsega Dodzi	D9b	0.4	1
987	Gideon Ahadzi	D9c	0.4	1
988	John Avevor	D9d	0.4	1
989	Paul Kwame Fiamegbe	D10a	0.8	2
990	Gershon Danyo	D10b	0.4	1
991	Gershon Ametefi	D10c	0.4	1
992	Kwame Tofu	D10d	0.4	1
993	Worfa Tordzagbo Adzormani	D9d	0.4	1
994	Torgbui Ashiakpor	D10c	0.4	1
	TOTAL			
NO	**SECTION 11 A BLOCK**			
995	Celestine Agoha	A1a	1.2	3
996	Kwabla Fiamegbe	A1b	0.4	1

997	Arnold Kwame Ametorwotia	A2a	0.8	2
998	Godwin Kunaki	A2b	0.4	1
999	James GAGODO	A2c	0.4	1
1000	Richard Galley	A3	1.67	4
1001	Micheal Kofi Tamakloe	A4a	0.8	2
1002	George Gbolo	A4b	0.4	1
1003	Agnes Torsu	A4c	0.4	1
1004	Jonathan Nkrumah	A5	1.67	4
1005	Akakpo Ayivor	A6a	0.6	1.5
1006	Rebecca Mensah	A6b	1.4	3.5
1007	Atsu Adamu	A7a	0.4	1
1008	Ametefe Kadzahlo	A7b	0.4	1
1009	Daniel Adade Amuzu	A7c	0.6	1.5
1010	Emmanuel Azah	A7d	0.4	1
1011	Enyonam Akpah	A7e	0.4	1
1012	Stephen Kunaki	A8a	1	2.5
1013	Kporwobe Nyatsi	A8b	0.8	0.8
1014	Kwasikuma Gakpo	A8c	0.4	1
1015	Jonathan Bedzra	A9a	1	2.5
1016	Kenyetorwo Ahiabor	A9b	0.8	2
1017	Anna Aku Afedo	A9c	0.6	1.5
1018	Martin Klutse	A10a	1	2.5
1019	Rapheal KLUTSEY	A10b	1	2.5
1020	Koshie Fiakeye	A10c	0.4	1
	TOTAL			
	SECTION 11 B BLOCK			
1021	Mathias Bokorvi	B1b	0.8	2
1022	Promise Bokorvi	B1a	0.8	2
1023	Mary Akpah	B2a	0.8	2
1024	Emmanuel Bedzo	B2b	0.8	2
1025	Mensah Normeshie	B3a	0.8	2
1026	Simon Ayivor	B3b	0.8	2
1027	Moses B. Bokorvi	B4a	0.8	2
1028	David Adadey	B4b	0.8	2
1029	Stella Adadey	B5a	0.8	2
1030	Kennedy Mensah	B5b	0.8	2
1031	Mawukoenya Ayivor Ziorkli	B6a	0.8	2
1032	Gilbert Kodzo Tamakloe-Ayivor	B6b	0.8	2
1033	Lucia Adade	B7a	0.8	2
1034	Sonkor Happo Agozi	B7b	0.8	2
1035	Yao Hodanu	B8a	0.8	2
1036	Hulade Bedzrah	B8b	0.8	2
1037	Patrick Afedo	B9a	0.8	2

1038	Victoria Aku Worgbah	B9b	0.8	2
1039	Grace Ass. of God Church	B10a	0.8	2
1040	Peace Yaogah	B10b	0.8	2
	TOTAL			
	SECTION 11 C BLOCK			
1041	Eli Kloke	C1a	0.4	1
1042	John Egli	C1b	0.4	1
1043	Samuel Deku	C1c	0.4	1
1046	Livingstone Bluawoforgbe	C1d	0.4	1
1047	Kwashiewor Dartey	C2a	0.8	2
1048	Agbowugbe Fietsu	C2b	0.8	2
1049	Kenneth Kwaku Fianu	C3a	0.8	2
1050	Akakpo Wuakpo	C3b	0.8	2
1051	Yaotse Ahiadorme	C4a	0.8	2
1052	Seth Afedo	C4b	0.8	2
1053	John Adzabolo	C5a	0.8	2
1054	Peter Kofi Tamakloe	C5b	0.8	2
1055	Amla Gbetornyeku	C6a	0.8	2
1056	Mansah Fialor	C6b	0.8	2
1057	31st Dec Women Mov't	C7	1.76	4.4
1058	Dotse Gbomittah Agbasa	C8a	0.8	2
1059	Etse Richard Afedo	C8b	0.8	2
1060	Frank Atorzuke	C9a	0.4	1
1061	Sromawuda Adade	C9b	0.4	1
1062	Jacob Adade	C9c	0.8	2
1063	Atsufui Afedo	C10a	0.8	2
1064	Paul Afedo	C10b	0.8	2
	TOTAL			
	SECTION 11 D BLOCK			
1065	Agbota Ahelegbe	D1a	1.8	4.4
1066	Moses G.K. Kpornu	D1b	0.4	1
1067	Darlington Ziorklui	D1c	0.4	1
1068	Christy Kaledzi	D1d	0.4	1
1069	Peace Ahadzi	D2a	1.2	3
1070	Yao Agbeli	D2b	1.2	3
1071	Agathar Etse	D3a	1.2	3
1072	Margaret Normeshie	D3b	0.6	1.5
1073	Samuel Kportsu	D3c	0.6	1.5
1074	Yaw Simon Segbenu	D4a	0.4	1
1075	Dodzi Ahiable	D4b	0.4	1
1076	Daniel Bokorvi	D4c	0.4	1
1077	Samuel Dogbatse	D4d	1.2	3
1078	Samuel Adade	D5a	1.2	3

1079	Monica Gbeti	D5b	1.2	3
1080	Seth Vondolia	D6a	0.8	2
1081	Agbemavi Kudzo Datsomor	D6b	0.4	1
1082	Famous Kwadzo Gada	D6c	1.2	3
1083	Gershon Ayivor	D7a	0.8	2
1084	Francis Kwaku Ayivor	D7b	0.4	1
1085	Gbeda Sowude	D7d	0.8	2
1086	Jacob Ayivor	D7c	0.4	1
1087	Paul Setsoafia	D8a	1.4	3.5
1088	Kwaku Xetor Russia	D8b	1	2.5
1089	Francis Kwadzo Kudolo	D9a	1.2	3
1090	Afawubo Adzorwani	D9b	0.8	2
1091	Raphael Agbota Letsu	D9c	0.4	1
1092	Torgbui Dzodor	D10a	0.4	1
1093	Medeadoe Ayima	D10b	0.4	1
1094	Agbota Gbevor	D10c	0.4	1
1095	Lawrence Wedanu	D10d	0.8	2
			75.7	

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