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Ghanaian Farmers' Personal Trait and Agricultural Technology Adoption: Consumer Behaviour Perspectives

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Abstract - The study of consumer behaviour has gained importance since it is used to pinpoint the elements that influence consumers' decisions to embrace or reject innovations. This study seeks to understand adoption and use of agricultural technologies through the analysis of Ghanian farmers' personal elements as inherent in consumer behaviour. Using a quantitative research methodology, 285 rural rice farmers in Ghana's Volta Region were randomly selected to participate in a cross-sectional survey that was used to gather data. The structural equation modelling method was used to test respondents' attitude, perceived complexity and self-efficacy to adopt agricultural technology. This study found that a farmer's attitude and self-efficacy to adopt and use agricultural technology were significantly positively correlated. The decision of adoption and use technology is however complex based on the varied attitude, self-efficacy and the technical requirement of the specific technology. The implication for this finding is relevant for technology marketing and regulatory policy to promote and support technology adoption and use by farmers in Ghana. The results, though relevant and valid in consumer behaviour and marketing, application context may vary widely requiring consideration of other variable for adaptation as envisaged in international marketing.

Keywords: Consumer behaviour, personal behaviour, Agricultural Technology Adoption, Rural farmers, Attitude, Technology complexity, Self-Efficacy

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1. Introduction

According to recent studies (Chandio & Yuansheng, 2018, Jost, et al., 2016), the implementation of agricultural technology has become an essential component in boosting productivity, sustainability, and economic growth within the agricultural sector of various countries. The effective integration of innovative agricultural technologies holds enormous potential for improving overall agricultural practices and rural livelihoods, particularly in developing nations like Ghana where agriculture is crucial to the livelihoods of a sizeable portion of the population (Banson, Nguyen & Bosch, 2018, Adnan, Nordin, Bahruddin, & Tareq, 2019). Improved crop varieties is also achieved as a merit of embracing agricultural technology (Awotide & Awoyemi, 2016). Farmers now have access to crop types that are frequently developed to outperform earlier generations (Kuehne, et al., 2017). However, due to the adoption process' complexity and multifarious nature, which is influenced by a range of factors, including socioeconomic conditions, infrastructural restrictions and personal behavioural characteristics of individual farmers (Banson, et al., 2018, Ofana, Efefiom & Omini, 2016), the adoption of such technologies among smallholder farmers is still low (Kuivanen et al., 2016).

This study explores the complex relationship between farmer behaviour on a personal level and the uptake of agricultural technology in rural Ghana. Three aspects of farmer personal behaviour that are operationalized in this study are farmer attitude toward agricultural technology adoption, farmer self-efficacy in adopting agricultural technology, and the perceived complexity of agricultural technology. According to Kim (2016), a farmer's attitude toward adopting agricultural technology is their set of beliefs, perceptions, feelings, and general dispositions. These attitudes can be influenced by a variety of factors, including perceived risks and benefits, an individual's creative spirit, prior experiences, social influences, knowledge, ease of use of the technology, environmental and financial considerations, and the degree of trust they have in the technology's source. The perceived difficulty of comprehending, acquiring, integrating, and maintaining new agricultural technologies is frequently referred to as the complexity of agricultural technology (McDonald, Heanue, Pierce & Horan, 2016, Verma & Sinha, 2018). Technical difficulties, operational complexity, maintenance requirements, user interface, availability of support and training, integration with current systems, quality of documentation, language and accessibility, and customization flexibility are a few examples of this. Farmers are less inclined to adopt technology that presents major impediments to its efficient and effective use, the higher the perceived complexity of the system. According to Venkatesh and Bala (2008) and Wuepper and Sauer (2016), farmer self-efficacy is a measure of a farmer's confidence in their own capacity to successfully accept and apply new agricultural technologies. A farmer's sense of self-efficacy can be derived from a variety of factors, such as their belief that they can overcome obstacles to successfully adopt and use new technologies, their problem-solving skills, their past successes, their perceived control over the factors influencing the technology's implementation and results, their perception of the availability of support systems, and the influence of social modelling.

Many studies have looked at the technological and socio-economic aspects of adoption (Gumataw et al., 2013, Kesley, 2013). Some researchers have only identified agricultural technology adoption as a problem (Asfaw, Shiferaw, Simtowe, & Haile, 2011, Bridle, L., Magruder, McIntosh, & Suri, 2020). Others examined the socio-psychological influences (Zeweld, Van Huylenbroeck, Tesfay, & Speelman, 2017, Elahi, Zhang, Lirong, Khalid & Xu, 2021, Sood, & Mitchell, 2004) but the role of personal behaviour in influencing this process has garnered less attention. To create tailored product information that appeal to farmers' interest and the marketing of agricultural technology, it is essential to comprehend how individual farmers' attitudes toward agricultural technology adoption, self-efficacy in adopting agricultural technology and perceived technology complexity impact adoption of agronomic innovations.

According to Donkoh, Azumah, and Awuni (2019) and Singha & Baruah (2011), the rural agricultural landscape of Ghana is characterized by a variety of farming practices, varied levels of education, and cultural nuances that collectively impact farmers' perceptions and behaviours. This study aims to investigate the association between farmer traits and farmer readiness to use agricultural technology. The study primarily intends to determine the links between rural Ghanaian farmers' attitudes toward adopting agricultural technology, perception of complexity of technology, self-efficacy in adopting agricultural technology, and adoption of agricultural technology. Insights from this study will not only advance knowledge of the dynamics of technology adoption in academia but will also have immediate application for stakeholders such as policymakers, development organizations, and NGOs working to advance sustainable agricultural development and rural transformation in Ghana. This will ultimately lead to improved livelihoods, increased food security, and improved agricultural sustainability.

2. Literature review

2.1 Types of agricultural technology

Three categories of agricultural technology were identified by Zheng et al. (2022). New crop varieties are the first category. "New crop varieties" are ones that cost more than common crop types but have higher disease resistance or more visible yield-increasing effects. Water-saving irrigation technology is the second category. According to Zheng et al. (2022, p.284), this is in reference to "...production technologies that can effectively save water, such as sprinkler irrigation, micro-sprinkler irrigation, subsurface irrigation, and drip irrigation." Straw-returning technology is the third category of agricultural technology. According to Zheng et al. (2022, p. 285), "Straw-returning technology refers to measures to increase fertility and increase production, which improve conventional incineration methods and avoid air pollution caused by incineration. These measures include 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. Various agricultural technologies that were adapted from production, processing, and post-harvest operations were identified in other investigations. Agriculture yield-enhancing technologies include mechanized ploughing, harvesting, and planting, as well as the application of fertilizer, better seeds, irrigation, higher soil tillage, and integrated pest management (Habtewold, 2021, Hu, Li, Zhang, & Wang, 2019). Branding, shipping, selling farm products, standardizing, and financing are all examples of post-harvest technology (Zhang, Sun, Ma, & Valentinov, 2020). Additionally, land-saving technology was identified by Hu, Li, Zhang, and Wang (2019), including greenhouses and zero grazing. Adopting agricultural technology in this study refers to doing so in a way that increases yield, such as through mechanization, which benefits rural farmers.

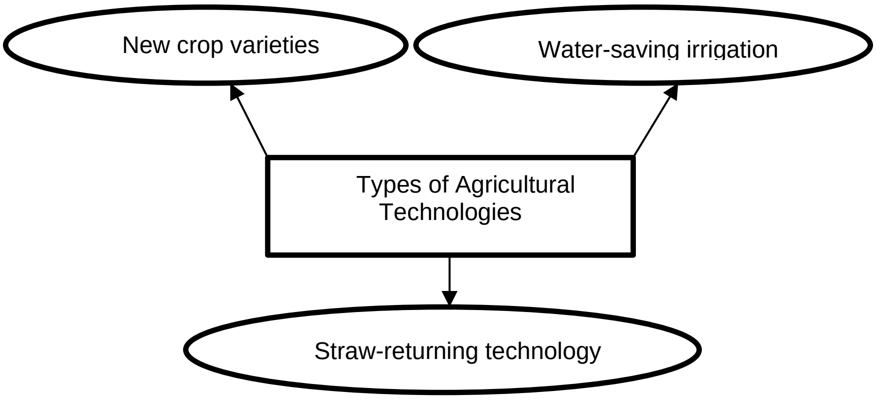

Figure 1: Types of agricultural technology: Authors' illustration

2.2 Consumer behaviour perspectives in agricultural technology adoption

Understanding agricultural technology adoption through consumer behaviour perspectives offers valuable insights into the factors that influence farmers' decisions in adopting agricultural technology. It is a necessary anchor for agricultural technology adoption as consumer behaviour patterns are ingrained in the adoption process (Bhardwaj, 2020). From a consumer behaviour stand, many manufacturers are 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). 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 (Diallo et al., 2013). Personal factors such as age, occupation, lifestyle, and personality affect consumer behaviour (Schiffman et al., 2013). Farmers as the consumers of agronomic innovations are influenced by the personal characteristics such as farmer attitude toward adopting agricultural technology, the complexity of agronomic innovations and farmer self-efficacy in adopting agricultural technology. 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. Zulqarnain et al. (2020) found that farmers with a positive attitude towards technology were not reluctant to adopt and use new technology. Farmers, by nature, are committed to routines, 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 (Danso-Abbeam, Dagunga, & Ehiakpor, 2020). 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 (Lindner, Rodriguez, Strong, Jones & Layfield, 2016). Self-efficacy also 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). 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.

2.3 Theoretical and conceptual frameworks

The theoretical stance of the study is represented by the Technology Acceptance Model (TAM) (Davis, 1989). According to TAM, one of the factors that predict behavioural intention and lead to the ultimate acceptance of innovations is attitude. In the context of technology adoption, attitude is defined by Kim (2016, p. 2) as "a person forming favourable or unfavourable feelings toward adopting a certain technology." According to Wang et al. (2012), people can be persuaded to have a favourable attitude, which results in a positive intention to use a certain technology, by the perceived ease of use and usefulness of a technology. According to earlier research (Adnan et al., 2019), attitude plays a significant influence in influencing behavioural intentions about technology adoption. The conceptualization and testing of the relationship between attitude and behaviour by Ajzen and Fishbein (1977) led to the discovery of a constructive relationship between attitude and behavioural intentions. The relationship between attitude and rural farmers' readiness to adopt agricultural technology is therefore explained by TAM.

The TAM is a theoretical framework that primarily focuses on two key factors influencing users' acceptance of technology: Perceived Ease of Use (PEOU) and Perceived Usefulness (PU) (Davis, 1989). There is an inverse relationship between Complexity of a technology and its perceived ease of use. According to Moore and Benbasat (1991) complexity features in Diffusion of Innovations (DoIT) as one of the five features of innovations, whilst PEOU is conceptualised as one of the salient beliefs when adopting new technology. The more complex a technology is, the more challenging it may be for users to grasp and use it easily. If a technology is too complex, it can lead to a lower perceived ease of use, which might hinder user acceptance. TAM explains the relationship between complexity of a technology and its adoption. Another theory used is the Decomposed Theory of Planned Behaviour (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. Control belief is decomposed into self-efficacy and facilitating conditions (Garay et al., 2019). According to Venkatesh and Bala (2008), the definition of self-efficacy is a person's confidence in what they can do 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. These new elements help to explain the impact of beliefs of behavioural intention to adopt a technology and offer a broader view than the traditional TPB. 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. The DTPB therefore established a relationship between farmers' self-efficacy and their intention to adopt technology.

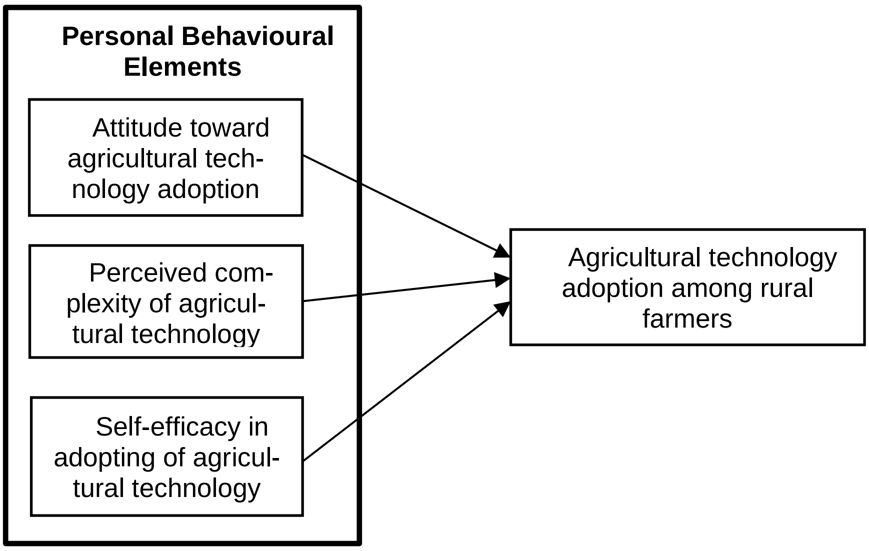

Figure 2 Conceptual framework

The key claim of this study is that smallholder farmers adopt agricultural technology due to personal characteristics such as attitude toward agricultural technology adoption, perceived complexity of agricultural technology and self-efficacy in adopting agricultural technology. The framework is predicated on certain presumptions. The three (3) aspects that make up the dimensions of adoption behaviour, which are conceived of as the independent variables, are farmer attitude toward agricultural technology adoption, farmer perceived complexity of technology and self-efficacy in adopting agricultural technology. These three (3) variables are anticipated to have significant influence on smallholder farmers' adoption of agricultural technology. The dependent variable is agricultural technology adoption (ATA).

2.4 Hypotheses and definition of variables

Farmer attitude toward agricultural technology adoption, self-efficacy in adopting agricultural technology and perceived complexity of agricultural technology are personal characteristics in this study. These three variables are thought to have an impact on how smallholder farmers in Ghana use agricultural technology.

2.3.1 Attitudes toward agricultural technology adoption

According to Massoro and Adewale (2019), Zossou, Arouna, Diagne, and Agboh-Noameshie, 2020), attitude is a psychological and individual construct that relates to how people assess and react to the world around them. Numerous academics have discovered over the years that a person's attitude can affect their behaviour and decision-making (Cafarro & Cavallo, 2019). According to this study's hypothesis and the literature, smallholder farmers' attitudes can influence whether or not they choose to use new agricultural technologies. For instance, Fishbein and Ajzen (1975) found that a person's outlook is influenced by their attitude, especially when it comes to assessing external stimuli and forming behaviours. According to Ajzen and Fishbein (1980), a person's attitude toward an object can influence whether that object is liked or disliked, favoured or rejected.

The attitude of a farmer affects whether they adopt new technology because their negative attitude or perception towards the technology might lead to detrimental behaviour (Shang, Heckelei, Gerullis, Börner & Rasch, 2021). Recent research has shown that while negative attitudes have a negative impact on behaviour, good attitudes have the opposite effect (Dadzie, Ndebugri, Inkoom & Akuamoah-Boateng, 2022, Elahi et al., 2022). Over the years, researchers have explored the controversy around the impact of attitude on consumer behavioural intentions. According to the majority of studies (Cavallo, Ferrari, Bollani, and Coccia, 2014, Nyairo, Pfeiffer, Spaulding, and Russell, 2022) ensuring that a person has a favorable attitude toward the idea, product, service, or change agent is the key to eliciting a desired behaviour.

In their study of farmers' knowledge and attitudes toward adopting new technologies, Chuang, Wang, and Liou (2020) discovered that attitude was a significant variable that was positively associated to and contributed to technology adoption. The intention to use technology can strongly correlate with positive attitudes that result from exposure to knowledge (Chuang et al., 2020). Therefore, it is hypothesized in this study that smallholder farmers' attitudes may be favourably correlated with their use of agricultural technology. This claim is supported by the observation that a smallholder farmer's assessment of the advantages of new agricultural technology influences the attitude they adopt toward its adoption (Yang, Zhou, & Deng, 2022). A farmer is more likely to use the technology if the knowledge they have helps them have a positive outlook. This study makes the following claim in light of the overwhelming available evidence:

H1: Attitude toward adoption of agricultural technology positively and significantly predicts ATA amongst smallholder farmers in Ghana.

2.4.2 Perceived complexity of agricultural technology

Past studies have found a link between complexity and adoption of agricultural technologies (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).

Perceived 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). 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:

H2: Perceived complex of agricultural technology has a negative effect on ATA.

2.4.3 Self-efficacy in ATA

Self-efficacy is one of the numerous characteristics that influence the adoption of technology, according to experts that have been examining these factors over time (Irby & Strong, 2013, Sharifzadeh et al., 2017). One of the individual elements influencing whether someone will adopt new technology is their sense of self-efficacy. The impact of self-efficacy on the adoption of agricultural technology is examined in this study. As stated on page 274 by Venkatesh and Bala (2008), Self-efficacy can be described as a person's confidence in their unique IT skills. Self-efficacy is a subjective concept because it arises from a person's assessment of their technological competence. This shows that a person's propensity to adopt new technology increases with their level of self-efficacy. In contrast, a person is less likely to accept a technology the lower their self-efficacy.

Self-efficacy's importance in ATA cannot be overstated. Smallholder farmers may feel less capable of adopting agricultural technology because of these limitations (McGinty et al., 2008, Castiblanco Jimenez, Cepeda Garca, Marcolin, Violante & Vezzetti, 2021). These It is possible that there will be a negative attitude about adopting new technology if these contextual elements cause the person to feel inadequate.

Self-efficacy has been operationalized as a direct or moderating variable in previous studies (de Veer, Peeters, Brabers, Schellevis, Rademakers & Francke, 2015, Kohnke et al., 2014, Lu et al., 2014) that influences people's behavioural intentions with regard to technology adoption. All of these researches cited successful outcomes and self-efficacy's influence on technology adoption. This serves as another motivation for the current study's conceptualization and operationalization of self-efficacy as one of the adoption behavioural factors causing ATA among Ghanaian smallholder farmers. Since researchers like de Veer et al. (2015) discovered that self-efficacy was positively connected to technology adoption and usage intentions among older adults, the importance of self-efficacy as a variable that predicts ATA is not reliant on the age of individuals. In the context of the agricultural industry, this indicates that if elderly farmers have or acquire self-efficacy, they can also accept agricultural technology. Self-efficacy thus stands out as one of the individual elements that affect and may help smallholder farmers in Ghana adopt agricultural technology. On the basis of this, the following hypothesis is put forth:

H3: Self-Efficacy is positively related to ATA amongst smallholder farmers in Ghana.

2. Adoption of agricultural technology

The many steps consumers and organizations take to get acquainted and knowledgeable about new or current technology are referred to as the technology adoption process (Kaur & Rampersad, 2018, Verkijika, 2018). The rate of innovation has accelerated in the twenty-first century, leading to the creation of new goods, services, technologies, agricultural seed types, tools, and processes (Xu et al., 2007, Zelenika & Pearce, 2013). The body of research shows that customers frequently need time to adjust before embracing new technologies (Liu et al., 2018). Consumers may find it difficult to accept new technology since it necessitates new knowledge, orientation, and behaviour (Edmondson, Bohmer, & Pisano, 2001, Atuahene-Gima & Murray, 2007). Consumers have various attitudes, personalities, and dispositions, which frequently leads into unpredictable behavioural patterns, claim Son and Han (2011). As a result, customers are probably going to react to new technologies in a variety of ways (Gera et al., 2020, Bhat, Bapat, & Mookerjeeet, 2021).

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).

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).

3. Methodology

3.1 Study area

Ho serves as the regional capital of the Volta Region, one of Ghana's sixteen administrative regions, which is situated east of Lake Volta and west of the Republic of Togo. Additionally, the Volta Region shares common borders with the Greater Accra Region, Eastern Region, and Oti Region. There are 18 administrative districts/municipalities in the Region. The largest indigenous ethnic group in the Volta Region is called the Ewe. The socioeconomic development of the region depends heavily on agriculture. Among the industrial and food crops farmed in the area are cereals, legumes, vegetables, oil trees, roots and tubers, pulses, and plantation crops (MoFA, 2022). The Volta, Northern, Upper East, and Upper West regions of Ghana are the country's four main rice-producing areas. Ghana's highest rice-producing region is the Volta Region. Approximately 400,000 tonnes of produce are added annually to the national stock from the Region (MoFA, 2022). The Weta Irrigation Scheme in the Ketu North District and the Aveyime Irrigation Scheme in the North Tongu District are the two main rice growing programs in the Volta Region. Small farmers can gain from the community-based irrigation infrastructure provided by GIDA. The Ministry of Food and Agriculture's official rice cultivation sector includes the Weta Irrigation Scheme.

3.2 Data collection and analysis

A questionnaire was adapted from Buabeng-Andoh (2018) who predicted and explained university students' intention to use mobile learning in schools on the construct of Attitude. Self-Efficacy items were also adapted from Vakilalroaia and Fatorehchi, (2015) who integrated both TAM and TPB to explore Iranian Airlines electronic ticket acceptance. The personal behavioural characteristics were measured with three constructs: Attitude toward agricultural technology adoption (A), Self-Efficacy in ATA (SE) and perceived Complexity of agricultural technology (COM) representing the independent variables whereas farmers' willingness to adopt agricultural technology represents the dependent variable. Each of these three constructs was measured with 7-items scaled with a Five-point Likert scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree). Another 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). The farmers' socio-demographic characteristics were also covered by the questionnaire. The TAM was the basis of the items. TAM explains Attitude to predict behavioural intention and results in the acceptance of technology.

Data was gathered from 285 of the farmers who were selected for the study using the random sample approach. The 285 farmers were chosen from among the 1,095 members of the agricultural association Weta Irrigation Scheme. Agri-extension officers provided assistance in the data collection. For the data analysis, Amos' Structural Equation Modelling (SEM) software was employed. Descriptive statistical techniques, such as frequency and percentages, were used to report the results about the socio-demographic characteristics of the individuals.

3.3 Measures

Path analysis was employed in the data analysis to measure the structural model and verify the proposed relationships. The association between the constructs and their indicators as well as between the latent variables was determined using the SEM analysis. Several tools for analysing variables and determining how they relate to research goals are included in the SEM suite.

3.3.1 Validity Analysis

The study measures both the convergent and the discriminant validity which are the requirement for establishing construct validity (Campbell and Fiske, 1959). Convergent validity measurement using Fornell-Lacker criterion requires the Average Variance Extracted (AVE) greater than 0.5 (Cheung and Wang, 2017). The convergent validity of the study was tested with Average Variance Extracted and Composite Reliability. The AVE of the items of the Personal Behavioural Elements = 0.737 with Composite Reliability of 0.976 and the dependent variable Adoption = 0.853 with Composite Reliability value = 0.974. 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 (See Table 1).

The discriminant validity is established to ascertain the distinctiveness of the constructs in the study (Henseler, Ringle and Sarstedt, 2015). 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 2. 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 PEBE = Personal i.e, AD = 0.924 > its correlation with PEBE = 0.745. Also, the square root of AVE for PEBE = 0.858, its correlation with AD = 0.745. The discriminant validity as per Fornell-Lacker criterion is established (See Table 2).

The study instrument's reliability was evaluated using Cronbach's alpha to measure internal consistency. The domains' Cronbach's alpha values were AD = 0.954 and PEBE = 0.928. Given that all items and the domain as a whole had an alpha of ≥0.70, which is deemed desirable by Snoek, Skovlund, and Pouwer (2007), the item internal consistency was deemed substantial. As a result, the questionnaire provides a valid means of assessing the personal behaviour of farmers in the adoption of agricultural technology in the Ghanaian context (Table 1).

Table 1: 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
PEBE	0.928	0.976	0.952	0.737

It is evident from Table 1's results that the instrument is deemed valid for the research.

Table 2: Discriminant Validity – Fornell-Lacker Criterion

	AD	PEBE
AD	**0.924**	
PEBE	0.745	**0.858**

4. Results

The socio-demographic profile of the study's sample of farmers is presented below in Table 3.

Table 3: Socio-Demography Characteristics of Participants (n=285)

Variable	Frequency	%
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

Total number of farmers recruited for the study was 285. The percentage was highest among people over the age of 55 (30.18%; 86), then people between the ages of 35 and 54 (29.82%; 85), and finally people between the ages of 25 and 34 (28.77%; 82). The age group with the smallest percentage, 18.0-24, had 5.61% (16). It implies that small-scale farmers are equally dispersed among people aged 25 to 34, 35 to 54, and above 54 in the study's study area. Most participants (123, 43.16%) claimed to have at least a basic education. About 25.26 % of farmers have completed their secondary education, compared to just over 14% who have tertiary degrees (from universities, polytechnics, etc.). The bulk of the smallholder commercial farmers in the area had low levels of education, as evidenced by this.

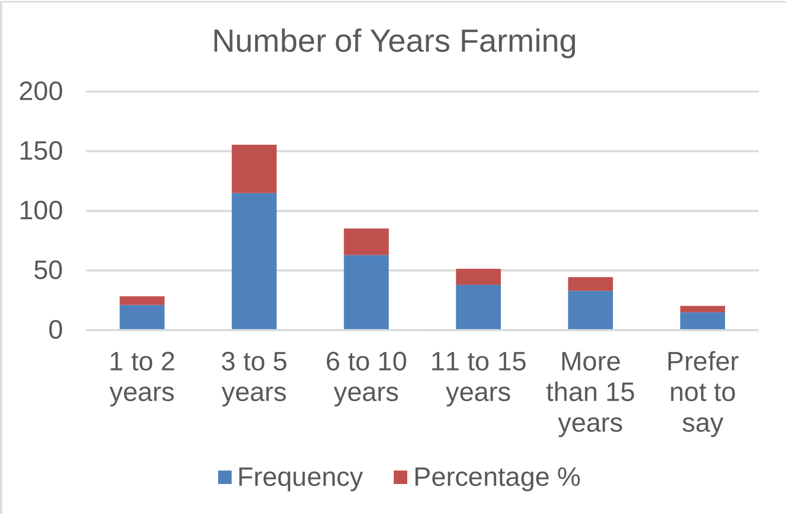

Figure 3: Number of years farming

From Figure 3 above, the majority of farmers (40.35%) have been engaged in rice farming for three to five years. The farmers have typically been engaged in rice farming for at least three years.

Table 4: Descriptive Statistics on Attitude toward ATA

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
Overall Altitude toward ATA	3.61	0.612

The findings in Table 4 show that participants generally agreed that using agricultural technology to increase yields is ethical (Mean = 4.02, SD = 1.022), desirable (Mean = 4.02, SD = 0.945), and excellent (Mean = 4.01, SD = 0.940). Participants also expressed strong agreement that adopting agricultural technology to increase yields is beneficial (Mean = 3.81, SD = 0.852) and that doing so is considered feasible (Mean = 3.77, SD = 0.673). Additionally, they felt that utilizing technology in their farming operations was not difficult (Mean = 1.92, SD = 0.483). In general, participants have a positive attitude toward using agricultural technology that increases yields in order to increase productivity (Mean = 3.61, SD = 0.612).

Table 5: Descriptive Statistics on perceived 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
Overall Complexity	2.27	0.337

In examining the personal behaviour of farmers, the study also considered how perceived complex agricultural technology is to be used or applied. It is shown that items measuring perceived 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).

Table 6: Descriptive Statistics on Self-Efficacy in ATA

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
Overall Self-Efficacy in ATA	3.75	0.640

According to Table 6, participants were confident in their ability to apply agricultural technology that increases yield (Mean = 3.71, SD = 0.824), and they were also confident in their capability to learn how to use the technology (Mean = 3.93, SD = 0.868). The high level of confidence also demonstrates that utilizing yield-enhancing agricultural technology can grow farm sizes (Mean = 3.88, SD = 1.053) and enhance yield (Mean = 3.81, SD = 0.796). Overall, it is demonstrated that farmers have a high level of self-efficacy while employing agricultural technology to increase yields (Mean = 3.75, SD = 0.640).

4.1 Agricultural technology adoption

Farmers' readiness to adopt agricultural technology was assessed in the study using six items, with the main focus being on how the aforementioned consumer factors listed above affect farmers' willingness to use agricultural technology. According to the opinions of the participants, Table 7 presents these findings.

Table 7: 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 expressed a strong desire to employ agricultural technology that increases yields in the future (Mean = 3.83, SD = 0.815). The replies demonstrate that participants have high expectations for using agricultural technology in their regular farming operations (Mean = 3.99, SD = 1.041). Participants also anticipate making frequent use of agricultural technology (Mean = 3.90, SD = 1.134). Participants further concur that they use and adopt agricultural technology for their regular farming operations (Mean = 3.51, SD = 0.803). Furthermore, they are willing to keep employing agricultural technologies (Mean = 3.73, SD = 0.896). Over all, smallholder rice farmers are often quite willing to use agricultural technology (Mean = 3.79, SD = 0.851).

The study further examined the connection between the personal behaviour of farmers in terms of attitude toward ATA, self-efficacy in ATA, perceived complexity of technology and the willingness to adopt agricultural technology. This relationship is modelled using the Structural Equational Modelling (SEM) shown in Table 8 and Figure 4.

Table 8: 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 agricultural technology adoption 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. However, Table 8 demonstrates that farmers' willingness to adopt agricultural technology is negatively impacted by the perceived complexity of agricultural technology in a statistically significant way. The unstandardized coefficient (-0.196) indicates that farmers' willingness to adopt technology decreases as it becomes more complex. Figure 4 shows a similar significantly negative relationship between farmers' willingness to accept agricultural technology and the degree of agricultural technology's complexity.

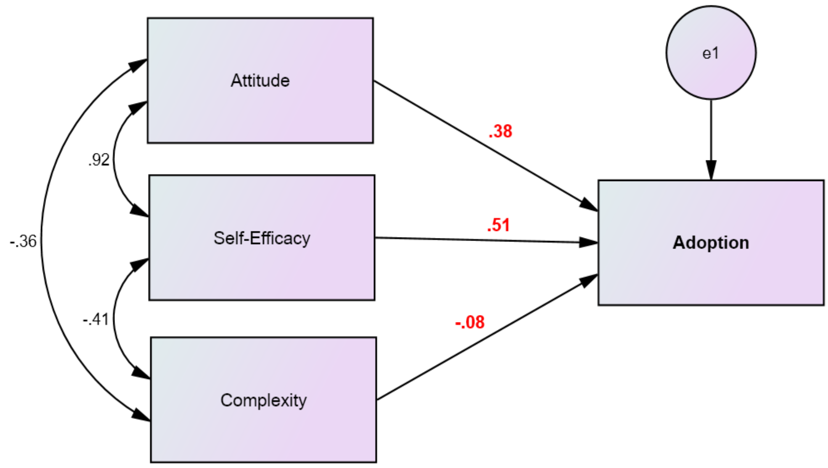

Figure 4: SEM between personal elements and adoption

5. Discussions

The study's descriptive data reveal that smallholder commercial farmers had a very positive attitude regarding using agricultural technology. The results of this study are consistent with the literature, demonstrating that the adoption of agricultural technology is significantly influenced by the mindset of Ghanaian rice farmers. Verma and Sinha (2018) claim that attitude is considered to be a powerful predictor of technological behaviour, which is seen in this study. Therefore, the rice farmer's behavioural intention to use agricultural technology is shaped by attitude. The beneficial effect, however, comes with a warning that, should farmer attitudes change, so would their desire to employ the technology. In contrast to the favourable impact found in this study, Kaler and Ruston (2019) found a detrimental impact of attitude on cattle producers' adoption and use of precision technology. If rice farmers' attitudes about technical advancements and tools deteriorate, a similar occurrence might take place in their situation.

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.

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.

The SEM linking the variables shows that consumer attitude significantly affects the willingness to adopt agricultural technology ($\beta=0.380$, $p=0.000$). 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 in ATA positively affects willingness to adopt agricultural technology, significant at a 95% confidence level ($\beta=0.511$, $p=0.000$). Among the personal behavioural elements, self-efficacy in ATA 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, perceived complexity in using agricultural technology significantly influences adoption negatively ($\beta=-0.078$, $p=0.005$). The study, therefore, rejects hypotheses H1, H2 and H3. It is inferred that rice farmers' attitude and self-efficacy significantly affect their willingness to adopt agricultural technology. On the other hand, the perceived complexity of agricultural technology has a significant negative effect on its adoption.

The study has limitations. Although Ghana in West Africa was the only country included in the study's sample, it was sizable enough to be representative of smallholder commercial rice growers. The selection of Ghana restricts the ability to generalize the findings because the agricultural technology infrastructure available to smallholder commercial rice producers varies in different regions. Compared to farmers in Europe and other parts of the world, farmers in Asia, for example, have access to distinct agricultural technology. They might, however, have similarities as well as differences. The study's findings only reflect the adoption practices of smallholder commercial rice producers in Ghana. To replicate the results of this study, comparative research should be carried out to identify the similarities and differences that exist in each region. In addition, there are many other crop farmers. These farmers may show different adoption behaviour of agricultural technology.

6. Conclusion

This study has enriched the theoretical understanding of technology acceptance by highlighting the unique influences of personal behaviour represented by farmer attitude toward agricultural technology adoption in rural agricultural settings. These insights contribute to refining and expanding TAM, making it more applicable and robust in diverse contexts. For instance, examining the link between farmers' attitudes towards technology and their actual usage behaviour provides empirical support for the predictive validity of TAM in the context of rural agriculture, reinforcing attitudes and behaviour in technology adoption.

Focusing on farmer self-efficacy in adopting agricultural technology and perceived technology complexity in the context of agricultural technology adoption in rural communities provide specific managerial implications to enhance the adoption process. Managerial strategies may include development of comprehensive training and education programs that build farmers' confidence in using new technologies with hands-on training sessions, workshops, and field demonstrations to improve farmers' skills and self-efficacy. Again, implementing incremental learning approaches that introduce technology in stages to allow farmers to build confidence gradually starting with simpler tasks and progressively moving to more complex ones can help farmers feel more capable. For practice, simplified technology designs can be introduced. Policymakers can advocate for the development and deployment of user-friendly technologies that require little training and are easy to understand and use with customized support materials such as easy-to-follow manuals, visual aids and instructional videos in local languages tailored to the literacy levels and technology familiarity of rural farmers.

The findings of this study indicated a positive relationship between farmers' personal consumer behavioural traits and their willingness to use agricultural technology to improve food security and reduce rural poverty. Therefore, MoFA should take into account, among other things, farmer consumer behaviour patterns while developing agricultural programs. Before choosing which agricultural technology to use in a particular place, research could be done to assess the personal traits of the local farmers. In order to increase the level of self-efficacy of farmers and have a positive attitude toward adopting agricultural technology to raise farm yields, ensure food security, decrease farmer poverty as favourable attitude toward the application of agronomic technologies is achieved.

The attitude toward ATA, self-efficacy in ATA and one's own assessment of the degree of complexity of technology are what define the consumer's personal behaviour in this study. The positive attitude of farmers has a favourable impact on their adoption of cutting-edge agricultural technology. Farmers' favourable views of technologies that boosted yields led to a sizable likelihood of adoption. The sentiments of smallholder farmers are favourable indicators of technological adoption. A farmer's behaviour is altered by their attitude, which increases their propensity to adopt technology. The adoption of technology is also positively influenced by farmers' self-efficacy in ATA. As farmers become more capable and confident in how to employ agricultural technology, adoption is more likely to occur. Farmers that have a strong feeling of self-efficacy or belief are more likely to use agricultural technologies. Also, complex technologies have negative influence on farmers. Finally, any agricultural technology adoption strategy should consider understanding of the personal behavioural traits of farmers to increase the rate of adoption.

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