

A Model for the Adoption and Effective Utilization of ICTs in Commercial Agriculture in Zimbabwe

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Abstract: *The turn of the 21st century saw Zimbabwe embarking on the Fast Track Land Reform Programme (FTLRP) which promoted new commercial farmers in the agricultural sector in the country. These new commercial farmers in post-FTLRP utilise basic ICTs like mobile phones which have less significance in revitalizing their farming activities. This study seeks to establish reasons behind the low level of ICT adoption and underutilisation by new commercial farmers in Zimbabwe. Using the critical realism philosophical paradigm, the study proposes a model for the adoption as well as effective utilisation of ICTs in commercial agriculture in the country. It is further argued that the adoption of ICTs in commercial agriculture remains a challenge in Zimbabwe especially in the post land reform era where farmers concentrate on using basic farming equipment such as pivots, telecommunication lines and water pipes previously put in place by former owners most of which are now vandalized. It is hoped that the new farmers in order to adopt new technology in farming should be trained through workshop and seminars on the use of ICTs for effective commercial agriculture. The Government of Zimbabwe is further challenged to review the land ownership policy especially on timely processing of ownership documents.*

Key words: Adoption, Acceptance, ICT, Commercial farming, model, effective utilization.

1. Introduction

Africa has been characterized as a failure with regards to food production for its population despite the fact that agriculture in Africa contributes up to 32% of GDP (Vink, 2013). In Zimbabwe, after the Fast Track Land Reform Program (FTLRP) of 2000, agricultural production took a nosedive (Anon, 2004). The once prosperous country often eulogised as the bread basket of Africa became a perennial beggar of food and as a result Non-Governmental Organisations (NGOs) became the source of livelihood for many Zimbabweans. The development of sustainable agriculture depends on the level of adoption of ICTs by the farmers (Chavula, 2014; Namisiko & Aballo, 2013). This study investigated the extent of adoption and level of utilisation of Information and Communication Technologies (ICTs) in commercial agriculture in Zimbabwe after its agrarian reform. Further, it proposes a model for ICT adoption in commercial agriculture in Zimbabwe through the understanding of current ICT investments by farmers, the required areas for ICTs in commercial agriculture and the relevant features for the proposed model.

1.1 Problem statement

The development of sustainable agriculture depends on the level of adoption of ICTs by the farmers (Chavula, 2014; Namisiko & Aballo, 2013). Effective adoption of ICTs in commercial agriculture has been proved to be significant in improving productivity in many parts of the world (Mzee, 2013; Tamoutsidou, 2013; Tata & McNamara, 2016). Modern ICTs have ameliorated the activities of commercial agriculture. ICTs have long been viewed as having great potential for improving decision making and production efficiency in agriculture. They can accelerate the process of agricultural technology transfer from research and development institutions to farmers (Tata & McNamara, 2016). Thus, access to ICTs could reduce transaction costs related to information searching and reduce knowledge and information asymmetries, particularly related to market price information as well as farming efficiencies. Currently, ICT adoption in commercial agriculture in Zimbabwe is very low. Therefore, the new commercial farmers in Zimbabwe are not productive because they are not utilising ICTs in their agricultural activities. ICTs enhance agricultural growth in production which in turn promotes economic growth in either upstream or downstream sectors with the potential of creating employment. Hence, a model for ICT adoption and its effective utilisation in commercial agriculture is required in order to help farmers to break through the blockade of technological isolation which has hindered their production efficiency.

1.2 Research questions and research objectives.

The main objective of the study was to develop a model for ICT adoption in commercial agriculture in Zimbabwe. In order to accomplish the following sub research objectives guided the study which was to:

- Determine the extent to which commercial farmers in Zimbabwe have invested in ICTs that support agricultural activities.
- Establish need areas for ICT investment in commercial agriculture in Zimbabwe.
- Identify the key features for the development of the model for ICT adoption in commercial agriculture.

To accomplish the objectives of this research was guided by the following research questions;

- To what extent has the new commercial farmers in Zimbabwe invested in ICTs that support agricultural activities?
- What are the need areas of ICT investment in new commercial agriculture in Zimbabwe?
- Which features are necessary for the development of a model for ICT adoption in commercial agriculture?

1.3 Article outline

This article is structured as follows; section 1 introduces the research paper and situates the importance of the research area. This is followed by the research problem statement on section 1.1, which indicates why the research was done. The research objectives and questions then follow on Section 1.2. Section 1.3 gives the article outline while Section 2 reviews literature informing the study. Section 3 presents the methodology employed, conceptual framework, data collection instrument used in this research and data analysis procedure. The research findings are presented on section 4 together with the discussion and data triangulation. Section 5 presents the conclusion of the research, the developed and expert reviewed model, its contextualization with the research questions, the model limitations and future research.

2. Review of related literature

The accumulation of knowledge in any domain is grounded on what others have found. Literature review informs researchers to make inroads to the current studies in order to establish the knowledge gaps separating previous findings and the targeted outcomes of the study to be conducted (Onwuegbuzie et al. 2012; Gunasekare 2015). The purpose of this section is to bring together and synthesises different research outcomes on the adoption of ICTs and their effective utilisation in commercial agriculture for purposes of stimulating further research.

2.1 Developing context

The 'development divide' refers to the gap between the world's richest and poorest individuals, families, groups, regions, countries or continents in overall levels of human development. These are measured against economic, socio-anthropological, cultural, and political variables. HDI is a universal metric used by the United Nations for measuring the level of human development in a given country (Potnis & Pardo 2008). A country with a low HDI is regarded as 'developing' while the one with a high HDI is classified as 'developed' (United Nations Development Programme 2016; UNDP 2016). In developing countries, human development has been and continues to be uneven among regions, communities, groups and individuals (UNDP 2016). Progress that has been realised has by-passed groups, communities, societies and some people have been left out. Some have achieved only the basics of human development, and some not even that. Sub-Saharan Africa in general and Zimbabwe in particular, exhibits characteristics of a developing context.

2.1.1 Commercial Agriculture in a Developing Context.

In most African countries, agriculture has proved to be a dominant sector as such plays a very important part in economic development and the future of Africa is closely knotted with the growth of its agricultural sector (OECD, 2008). According to Korma (2007), agriculture has proved to be the backbone of the Least Developed Countries (LDCs) and accounts for between 30 to 60 percent of the Gross Domestic Product (GDP). Among the LDCs, agriculture employs more people, as compared to

other sectors and it represents a major source of foreign exchange. Furthermore, it provides the greater part of basic food and delivers subsistence and other income to over 50 percent of the LDCs' population hence the need to develop sustainable agriculture. According to OECD (2008), Africa's would-be with respect to commercial agriculture, is largely unexploited and the existing status of agriculture is a source of key concern as the sector is dominated by deprived smallholders, often involved in subsistence and agribusiness is its embryonic stage in most countries.

2.1.2 Impact of ICTs on Development

The adoption of ICTs in commercial agriculture has risen in the global scale (Irungu, et al., 2015; Tamoutsidou, 2013). The strategic approach to ICT in agriculture, the largest economic sector in Sub-Saharan Africa countries, offers the greatest breakthrough in economic growth in world economies. According to Asenso-Okyere & Mekonnen (2012), ICTs are a significant development feature in modern agriculture. The emergency of ICTs has improved the practice of modern-day agriculture. Commercial farmers can now use ICTs for irrigation and harvesting which is economic in terms saving labour. ICTs such as mobile phones, wireless and web technologies provide a platform essential for farmers' to improve productivity (Awuor, et al., 2016; Syiem & Raj, 2015). ICTs are one of the predominant matters that have become important in the field of agriculture. The adoption of new production techniques driven by development in ICTs has led to improved agriculture productivity in developed countries (Achugbue & Anie, 2011; Czapiewski, et al., 2013).

2.2 ICT AND AGRICULTURE DEVELOPMENT

ICTs in agriculture is an emerging field focusing on the enhancement of commercial agriculture and have gained traction in several farming regions. ICTs have become more visible in the field of agriculture over the years. According to Asenso-Okyere and Mekonnen (2012), it has been long recognised that the success of the development process in any sector is anchored in ICTs and access to ICTs has been presented as the target of the **SDG 2**, which emphasises on the merits of new technology in the fight against hunger. Turning to agriculture, Asenso-Okyere and Mekonnen (2012) point out those ICTs have been used to provide innovative solutions in commercial agriculture.

2.2.1 Significance of ICTs in Agriculture

Agricultural decisions on preparation of land in a timely manner, when and what to plant: weeding, irrigation mechanisms, harvesting, storage and marketing of produces have always been concerns at the centre of agricultural stakeholders (Zahedi & Zahedi, 2012). The significance of ICTs for agricultural development in general and for the commercial agriculture in particular, is extremely high in improving productivity and efficiency throughout the farming cycle (Singh, et al., 2015). ICTs hold a lot of potential towards the efficiency of commercial agriculture (Williams & Agbo, 2013). The use of ICTs in agriculture has become important in the modern world (Mahant, et al., 2012). ICTs play a vital role in all agricultural phases. ICTs have allowed for innovations that bring effectiveness and efficiency in farming activities. A lot of ICT initiatives have been proposed in the field of agriculture (Mahant, et al., 2012). ICTs especially mobile telephones enable farmers to have access to information at a lower cost (Musungwini, 2016). They also allow farmers to interact among themselves and the market. Farmers can access information on product prices and production technologies (Zhang, et al., 2016).

2.2.2 Relationship between ICTs and Agriculture Development

Globally, research has indicated that the active use of ICTs occupies an important apartment in the development of commercial agriculture (Casaburi & Kremer, 2014; Czapiewski, et al., 2013; Dey, et al., 2008; Glendenning & Ficarelli, 2012; Mzee, et al., 2013; Tamoutsidou, 2013). According to Williams and Agbo (2013), ICTs are progressively becoming part of the relationship between Agro-information and Agricultural activities. Information is very critical in the development of any agricultural sector. Therefore, ICT plays an important role by making the farmers aware and conscious to scientific information and technology required in commercial farming. Hence, commercial farmers need to espouse ICTs in order to become technologically relevant in modern agriculture (Zahedi & Zahedi, 2012; Mittal, 2012).

2.2.3 Models of ICT adoption and Effective Utilization of ICTs in Agriculture

Several models have been used to describe the way in which new innovations which include ICT solutions can be accepted (Oliveira & Martins, 2011). The major theories include the Technology Acceptance Model (TAM) propounded by Davis in 1989, Theory of Planned Behaviour (TPB) proposed (Ajzen, 1989) and Ajzen (1991), Unified Theory of Acceptance and Use of Technology (UTAUT) as advocated by Venkatesh et al. (2003) and Diffusion of innovation theory (DOI) developed

by Rogers (2003). However, in this study, the researchers developed on TAM and DOI. This is because the two models put more emphasis on the acceptance and adoption of innovation by individuals or community. In this regard, the farmer is the individual while commercial farmers represent a community.

According to Oliveira and Martins, (2011), the Technology Acceptance Model (TAM) is a theoretical model that explains how users come to accept or adopt and use technological innovations. The major theoretical constructs of this model are perceived usefulness and ease of use. Rota et al (2013) posit that perceived usefulness is the extent to which individuals view the benefits of using technology. This model predicts how individuals use technology. Furthermore, the perceived ease of use is a highlight of how difficult or easy is the technology to the user to operate. Thus, a correlation exists between these two constructs. The model has been used as a guiding context for several studies on user acceptance of technology.

Diffusion is the process by which an innovation is adopted by members of a certain community (Hashim, 2007; Osorio-Gallego, et al., 2016). Diffusion takes place over time with innovations going through a slow, gradual growth period, followed by dramatic and rapid growth, and then a gradual balance and finally a waning (Nchunge & Sakwa, 2013). The development of this theory was founded on the study of technological change in agriculture using as a case study the ten-year lag. Many studies have suggested that those who intend to study the adoption of innovation should be guided by the DOI (Carolina 2009 & Marez et al 2011). According to Rogers (2003), the theory is a synthesis of innovation decision process, the individual innovativeness theory, the rate of adoption theory and the theory of perceived attributes.

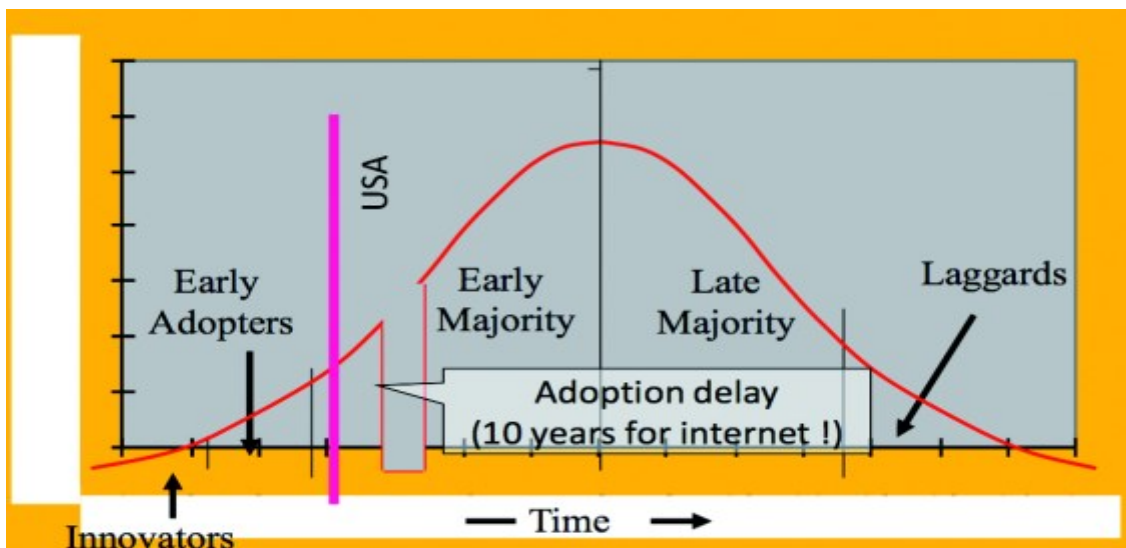


Figure 2: Diffusion of Innovation theory (Source: Rogers, 2003)

As indicated by Figure 2.2 above, developed countries were the early adopters of ICT in agriculture and ICT in agriculture witnessed a ten-year adoption delay. The innovation process follows a bell-shaped curve. Based on literature review, it can be argued that this is the group which the majority of commercial farmers from developing countries fall.

3. Methodology

This section introduces the conceptual framework for the adoption and effective utilization of ICTs and the methodology used in this research. The conceptual framework is graphically portrayed showing the important concepts of this research and their linkages. The framework provided the researchers with guide to designing of the research instruments and processes and procedures followed in carrying out this research.

3.1 The conceptual framework

According to Imenda (2014), a conceptual framework is a product of synthesised related concepts. In addition to concepts found from the literature, a conceptual framework may also be constructed from

views, beliefs and assumptions of the researcher(s) (Bentahar & Cameron, 2015; Miles & Huberman, 1994) and it can be in graphical form or narrative. The conceptual framework is used in place of the theoretical framework when the research problem cannot meaningfully be researched in reference to only one theory. Hence, this conceptual framework is a synthesis of the concepts borrowed from the TAM model and the DOI theories.



Figure 1: Conceptual framework for the adoption and effective utilization of ICTs.
(Source: authors' own construction)

3.2 Data collection instruments

This research used different data collection instruments because the researchers believed that the instruments will complement each other enables the validation of findings of this research. The instruments used are interviews, questionnaires and expert reviews.

3.2.1 Interviews

According to (Gill, et al., 2008), the aim of the interview is to discover how individuals perceive specific matters. It was appropriate in this study because the researchers had little knowledge on the need areas of ICT investment in commercial agriculture and such insights were required from the individual participants (Gill, et al., 2008). Each interview lasted between 30 to 45 minutes as suggested by Collins & Kavanagh (2013). The study used semi-structured interviews which involved open-ended questions about the area under investigation. This type of interview enabled the researchers to control the scope of the study so that the interview remains focused on the data needs of the research. Furthermore, the researchers made follow-ups on previous responses that had proved unsatisfactory.

3.2.2 Questionnaire

A questionnaire is a data collection form used to solicit responses research participants. Vosloo (2014), describes a questionnaire as a list of questions where answers of respondents are recorded. The questionnaire served as a standard guide for the researchers to collect consistent data by asking the questions in exactly the same way. Without this standard, questions would be asked in a disorganized way at the will of the individual.

Structured questionnaires were used to collect quantitative data. This enabled the researchers to obtain uniform responses that were later subjected to quantitative analysis. The researchers provided pre-defined answers derived from literature review. The researchers made an effort to anticipate all the possible answers so as to increase data validity.

3.2.3 Expert Reviews

The technique is an iterative, well-thought-out communication technique that depends on the point of view of experts in a certain area of study, and is grounded on the notion that the judgments and views believed by these experts are considered as more valid or respected than those held by individuals (Megaw, 2010). In this study, expert reviews were used to validate and review the findings of this research which included the model for adoption of ICTs in commercial agriculture that was developed from these findings.

3.3 Data analysis

The researchers commenced data analysis by removing unusable responses. The criterion for usability of the questionnaire had been set 85% (Schaub, Friedrich & O'Sullivan, 2014). Quantitative data was analysed using descriptive statistics from SPSS version 23 and presented using percentages and frequencies. The information was displayed using statistical techniques such as bar charts, histograms and pie charts. This was done by tallying up responses computing percentages of variations in response as well as describing and interpreting the data in line with the study objectives. The test to ascertain whether there was indeed low adoption was handled by Chi-square then followed by appropriate analysis. On the other hand, qualitative data was analysed using structural coding (Saldana, 2010) which is a question based coding technique. Qualitative data was then presented in themes.

4. Findings and discussion

This section presents the findings of the research and the discussion. This research the data collection was done concurrently and no approach was given primacy over another. It just happened that the researchers commenced presentation of findings with qualitative.

4.1 Interviews

According to Sutton (2015), the presentation of qualitative findings is based on the narrative form grouped according to developed themes. Themes can be Theory-Driven or data Driven (Gläser, 2013). Themes used in this study were Theory-Driven. According to Gläser (2013) the development of Theory-Driven themes is consistent with the existing theory. Hence, many researchers have adopted this approach because it gives researchers a starting point for data analysis. More so, themes must be supported with the direct quotations from the interview transcripts to substantiate evidence (Flick, 2013).

4.1.1 Themes development

This section provides an outline of how themes were developed from the interview data. The major themes are presented in Table 1 below.

Table 1: Global and respective sub themes (n=8) (Source: Primary data)

Global themes	Sub themes	Number participants	Percentage
ICT investment in commercial Agriculture	Low level of ICT investment	8	100%
	Low level of ICT usage	6	75%
Factors affecting ICT adoption	Investment costs	6	75%
	Government policies	7	87.5%
	Awareness	8	100%
	Electricity Power constraints	5	62.5%
Need areas of ICT investment	Soil management	5	62.5%
	Post-harvest processes	7	87.5%
	Irrigation	6	75%
	Marketing	8	100%
	Weather monitoring	7	87.5%
	Research and Development	6	75%
	Pest control	5	62.5%
Components of ICT adoption model in commercial agriculture	Training of farmers	6	75%
	Government policy	7	87.5%
	Promote farmers' awareness	7	87.5%

4.1.2 Themes discussion

The previous subsection presented the themes developed from interview data using Theory-Driven coding. Now that themes have been developed, this subsection discusses the themes supporting them with interview narratives.

ICT investment in commercial Agriculture

Interviews conducted with the farmers enabled the researchers to establish the extent of ICT investment in commercial agriculture in Kwekwe district. The purpose of this theme is to show the extent of ICT investment in commercial agriculture particularly in Kwekwe district. Respondents were asked using semi-structured interviews to outline the ICTs that they have and use in their farming activities. Two major themes were developed from their narratives. These are Low level of ICT investment and Low level of ICT usage. The extent of ICT investment simply means the number of ICTs found in commercial agriculture and their relative use.

Low level of ICT investment

According to the respondents, most of the commercial farmers in Kwekwe district have mobile phones and televisions. However, very few indicate that they have VSAT, Routers, Computers, Information Systems, GPS, Printers, Time Domain Reflectometry Systems. Participants revealed that commercial farmers in Kwekwe district are still lagging behind in terms of ICT investments. The technologies they use are mostly information disseminators. Furthermore, participants expressed great concerns on the level of adoption of ICTs in the district. Their narrations demonstrate that the farmers have only invested in traditional technology which is very basic and less significant to support their commercial activities.

Low level of ICT Usage

The participants during interviews indicated that in most cases use mobile phones, television and telephones for communication. This is because these are the most technologies affordable by many farmers in the district. Data reveals that availability of technology also influences its level of usage. This implies that farmers are not expected to use technology that they do not possess. As a consequence, there is low level of ICT usage by commercial farmers in Kwekwe district.

Factors affecting ICT adoption

Interviews were conducted with the commercial farmers to determine the factors affecting the investment of ICTs that has the pedigree of supporting commercial agriculture. During the interviews, all the participants were given the chance to outline the factors that affect farmers in Kwekwe district to invest in ICTs that enhance better productivity. The problems identified by the participants are as follows:

Investment Costs

Respondent agreed that ICT investments are associated with high cost. It was revealed that ICT investment is expensive and needs funding. Most interviewed farmers indicated that they do not have enough financial resources to invest in ICTs for commercial agriculture. Findings show that modern ICT investment for commercial agriculture is very expensive to farmers. Because of the associated costs, the majority of farmers in Kwekwe district have not successfully adopted ICTs for commercial activities. According to Titus (2016), lack of ICT adoption has been attributed to high costs of investments. Thus, modern technology is very costly for farmers in developing countries and requires sound investments.

Government Policy

In Zimbabwe, farmers are mainly faced with ICT policies and land tenure issues. The government has been very reluctant to come up with policies that promote ICT investment in commercial agriculture. In addition, there has been some delays in processing land tenure for the farmers. These findings show that commercial farmers in Kwekwe district are disadvantaged by unsupportive government policies. It can be argued that government policies in Zimbabwe do not capacitate farmers to invest in ICTs. In other words, the government's role with respect to supporting commercial farmers in adoption of ICT is a key to their successful investment. Asenso-Okyere and Mekonnen, (2012) also argue that policies have constrained the adoption of ICTs especial in developing economies. The adoption of ICTs needs supportive policies that provide enabling environment for innovation. According to Awuor, et al. (2016), effective adoption of ICTs depends on the appropriate supporting policies that provide environment that is conducive for ICT intervention. Therefore, there is need to revive both ICT and related policies in Zimbabwe.

Awareness

Respondents indicated that ICT investments are strongly related to the level of awareness. It was revealed that people do not invest in something that they are not aware of in terms of availability, accessibility and benefits. Findings show that farmers need to be aware of the availability and benefits of ICTs that meet their need. It can be seen that low level of awareness is associated with low level of investment and adoption. Similarly, Olumba (2014) found out that the adoption of ICTs for commercial agriculture was relatively low because farmers' awareness level was also significantly low. Thus, the level of awareness plays an important role in the adoption of ICTs. Therefore, the levels of awareness of farmers need to be improved in order to get knowledge about the availability and the benefits of ICTs relevant to their commercial activities.

Electricity power constraints

Most of the respondents identified lack of electricity supply in farms as a major contest to the effective investment of ICT in commercial agriculture especially in Kwekwe district. The district has not fully benefited from the Rural Electrification Programme (REP) which is being spearheaded by the Zimbabwe Electricity Supply Authority (ZESA).

Respondents were in agreement that electric power constraints affect ICT investments. The comments from the respondents suggest effective ICT investments are not possible if farmers do not have access to electricity. This is because most of the technology required for commercial activities need to be powered by electricity.

4.2 Survey

This section presents quantitative data that was obtained from the farmers using the questionnaire survey as the research instrument. The subsection consists of the response rate, demographic profile, ICT investments and need areas of ICTs.

4.2.1 Response Rate

According to Zoabi (2013), the validity and usability of data obtained from the questionnaire survey hinge on the response rate. This is the number of people who answered the questionnaire against the total sample. A response rate is very important because it enables other researchers to judge the validity of findings. Hence, it must not be ignored during data presentation. The most common formula used to calculate the response rate is presented below:

$$\text{Response Rate} = \frac{\text{total number of responses}}{\text{total number of sent questionnaires}} \times 100\%$$

Table 2: Questionnaire survey response rate (Source: Primary Data)

Questionnaire	Frequency (F)	Percentage (%)
Sent/scheduled	70	100%
Returned	62	88.57%

Table 2 above, shows the response rate obtained from the questionnaire survey. The researchers self-administered 70 questionnaires to the commercial farmers in Kwekwe district out of which 62 were returned. Only 4 questionnaires had missing details on level of education qualifications of the respondents hence yielding an error of 6.45%. However, the error was negligible because according to Schwarzenbach (2014), an error less than 8% is considered insignificant for data analysis. Hence, it did not affect the quality of data. Using the formula presented earlier on, the questionnaire achieved a response rate of 88.57%. Based on the accepted rule of (70%) proposed by Rubin and Babbie (2009), the researchers considered the data as valid for presentation and analysis. According to Rubin and Babbie (2009), a response rate of 70% is considered to be very good.

4.2.2 Demographic Profile

This subsection presents the demographic details of the respondents. The questionnaire was designed to solicit the demographic profile of the respondents of the study. The respondents were requested to provide their land ownership type, age bracket, level of education and crop category. These variables constituted the key characteristics of the study population.

4.2.3 Responses by land ownership

The respondents were asked to indicate on the questionnaire their ownership type of the land and the results are shown in Figure 3 below.

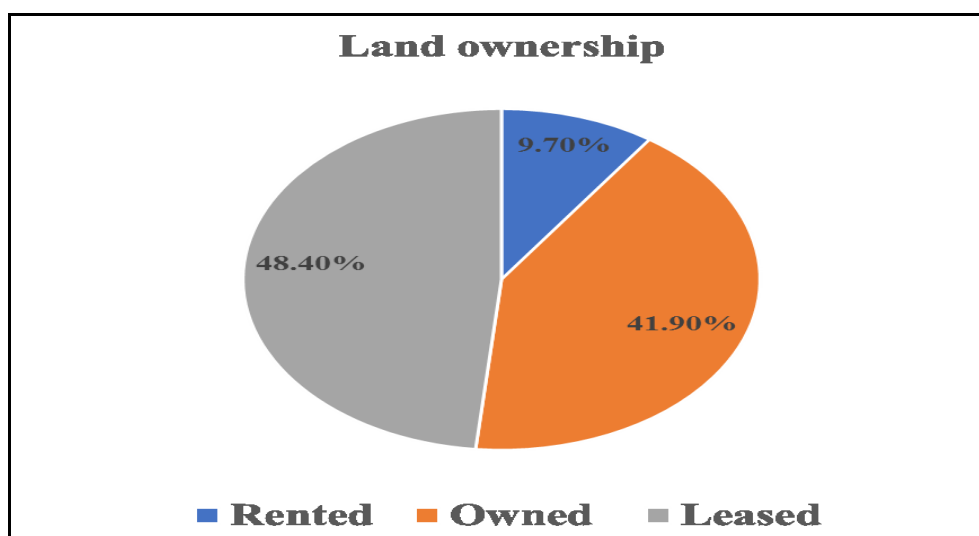


Figure 3: Farmers by land ownership (Source: Primary data)

As can be seen from Figure 3, 48.49% of the respondents are on lease category, while 41.90% have full ownership and 9.70% rented the land. The data shows that only less than half of the respondents have the right ownership of the land in Kwekwe district. This is an amazing finding considering that the 21st century land resettlement programme in Zimbabwe is now 17 years old. Ownership of the land presented a significant factor of the study to evaluate whether or not land ownership is correlated to ICT investments of the commercial farmers. However, according to Bejtja (2015), there are greater investment incentives when there is land tenure security. This implies that a country whose farmers have no land tenure security is likely to experience less investment than those with land tenure security. This is compounded by the fact that if farmers do not fully own the land, they have no control over their investments. Hence, they will be reluctant to invest in areas such as ICTs.

To ascertain if the distribution of Investment in ICT is the same across categories of Farm Ownership in Kwekwe district, a test revealed that Farm Ownership had a bearing in the observed investment pattern which showed that the distribution is not the same.

4.2.4 Response by age

The respondents were asked to indicate on the questionnaire their age category. Table 3 shows the age category of the farmers.

Table 3: Farmer responses by age (Source: Primary data)

Age category (years)	Frequency (F)	Percentage (%)
20-30	0	0
31-40	12	19.4
41-50	19	30.6
51-60	20	32.3
Above 60	10	16.1

As shown in Table 3 above, no farmer in Kwekwe district is less than 30 years old, while 19.4% of the farmers are between 31-40 years, 30.6% are between 41-50 years, 32.3% are between 51-60 years and 16.1% are above 60 years. This is an indication that most of the respondents were between 41-60 years. The age category corresponds to the fact that most people in Zimbabwe are between 41 and 60

years are considered to be mature adults who are also expected to be well established either in rural area or urban.

As noted by Falys (2015) people at 40 years are regarded as mature adults who can make sense of their lives through farming. This shows that at 40 years of age a person is eager to own his or her land. It was discovered that the distribution of Investment in ICT is the same across categories of age and as such it can be concluded that low adoption of ICTs in the district is not in any way attributed to the age factor.

4.2.5 Response by level of education

The respondents were asked to indicate on the questionnaire their level of education and the results are shown in Figure 4.

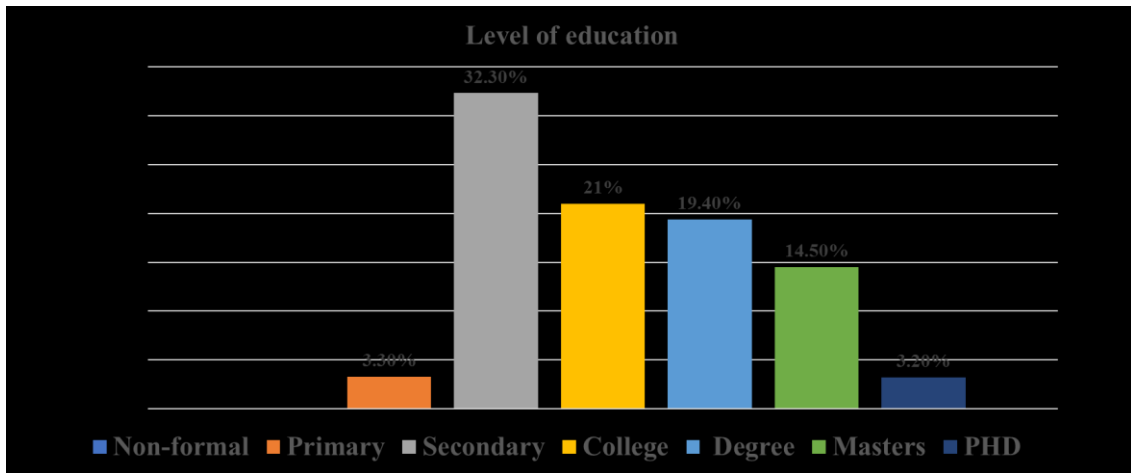


Figure 4: Farmers’ level of education (Source: Primary data)

Figure 4 represents the highest level of school education held by the commercial farmers in Kwekwe district. Of the respondents, 3.3% have only primary education, 32.3% secondary education and 21% have College Diplomas. 19.4% are university undergraduate degree holders, while 14.5% hold Masters Degrees and 3.2% have PhDs. The results show that the majority of farmers in Kwekwe district did secondary education. Thus, generally, farmers in Kwekwe district are well educated which can be linked to the education policy of Zimbabwe which saw many people getting access to education after independence.

4.2.6 ICT investments

The farmers were asked to indicate on the questionnaire the ICT type they own and its frequency of use. The results are presented in Table 5 below.

Table 5: ICT type ownership and frequency of use (Source: Primary data)

ICT type	Ownership	Frequency of use				
		Never	Seldom	Sometimes	Often	Always
Telephones	40.3%	-	1.6%	11.3%	17.7%	9.7%
Mobile phones	98.3%	1.6%	-	3.2%	17.7%	75.8%
Computers	54.9%	-	3.2%	11.3%	21%	19.4%
Printers	24.3%	-	-	9.7%	8.1%	6.5%
Internet	42%	-	-	6.5%	16.1%	19.4%
TDRS (Soil moisture tester)	6.4%	-	-	3.2%	-	3.2%
TV	54.8%	-	-	4.8%	17.7%	32.3%
External Storage Devices	22.6%	-	-	12.9%	3.2%	6.5%
Market information systems	12.9%	-	1.6%	4.8%	-	6.5%
GPS	6.4%	-	-	3.2%	-	3.2%
Remote sensory	1.6%	-	-	-	-	1.6%
Regulatory systems	6.4%	-	-	-	4.8%	1.6%

As can be seen in Table 5 above, the majority (98.3%) of farmers in Kwekwe has mobile phones and this type of ICT is always used by 75.8% of the farmers. The other ICTs found in Kwekwe districts with varying degree of use include Computers, Printers, Internet, TDRS (Soil moisture tester), TV, External storage devices, Market information systems, GPS, Remote sensory and Regulatory systems. This shows that most farmers prefer mobile phones ahead of other technologies. A mobile phone is a technology which can be owned by anyone and not peculiar to commercial farming. The findings concur with the findings of Joshi (2012) about two thirds of Africans now have mobile phones, including many in rural areas. Findings are also in agreement with Wesolowski (2012) who notes that most people always use mobile phones for their day-to-day communication. Thus, due to high level of penetration of mobile cell phones, the majority of people have easy access to this technology.

4.3 Triangulation and discussion

Concurrent triangulation was used and this implied that quantitative and qualitative data was collected and analysed at the same time. Because two data collection methods were used for various sources, it meant that data triangulation and methodological triangulation had to be used.

It was found that most of the respondents (77.4%) were in agreement that perceived benefits may affect the investment of ICTs in commercial agriculture. As for the ease of use, more than half of the respondents (82.2%) were in agreement that ease of use may affect ICT investment in commercial agriculture. With regards to level of awareness, most of the respondents (93.6%) were in agreement that technological investments are affected by the level of awareness. Hypothesis testing showed that there is low level of adoption of ICTs in commercial agriculture in Kwekwe. Farmers are only using basic ICTs which have less significance in revitalizing the farming activities. As a result, the adoption of ICTs in commercial agriculture remains an issue in Zimbabwe.

It was further discovered that high costs may affect ICT investments in commercial agriculture. On restrictive government policies which have implications on the adoption of ICTs, it was shocking to find out that the majority (53.3%) of respondents were in disagreement that restrictive government policies may affect the ICT investment in commercial agriculture. For the level of education, the majority of the respondents (88.7%) agreed that the level of education may affect the adoption of ICT in commercial agriculture though in the district that was under study, the distribution of ICT investments appeared uniform across different educational levels. It was also found out that farmers need a variety of ICTs for pest control, post harvesting, irrigation, water management, marketing and weather forecasting. The study also identified three major components for ICT adoption in commercial agriculture which are Training, Government policy and Awareness campaigns. These elements are critical in the development of commercial agriculture.

Generally, ICTs are only used for information gathering and dissemination. This has been attributed to the uneven distribution of technology across the world. This implies that African countries have less control over the diffusion of technology. This has resulted in diffusion gap of technology between developed countries and those in the developing world. Unless the technology diffusion gap is closed, Africa will continue to experience low level of ICT utilization, especial in commercial agriculture where the diffusion curve is perceived to be low (Shaijumon, 2014).

5. CONCLUSION

The purpose of the study was to develop a model for ICT adoption in commercial agriculture in Zimbabwe. The three major research objectives were achieved. Findings show that there is low level of adoption of ICTs in commercial agriculture in Kwekwe. In addition, factors that affect the adoption of ICTs in commercial agriculture were established. The factors were consistent with previous studies. Lastly, the components of the model were also identified. The study concludes that there is indeed low level of adoption of ICT in commercial agriculture as evidenced by the results of tests conducted to ascertain the level of adoption. We developed a model based on literature review and practical field research. We believe that our model may be used for the adoption and effective utilisation of ICTs in agriculture in a developing context, especially countries that have gone through agrarian reforms.

5.1 The model

This section presents the proposed model. The model suggests the possible ways in which the extent of investment and use of ICTs in commercial agriculture may be improved.

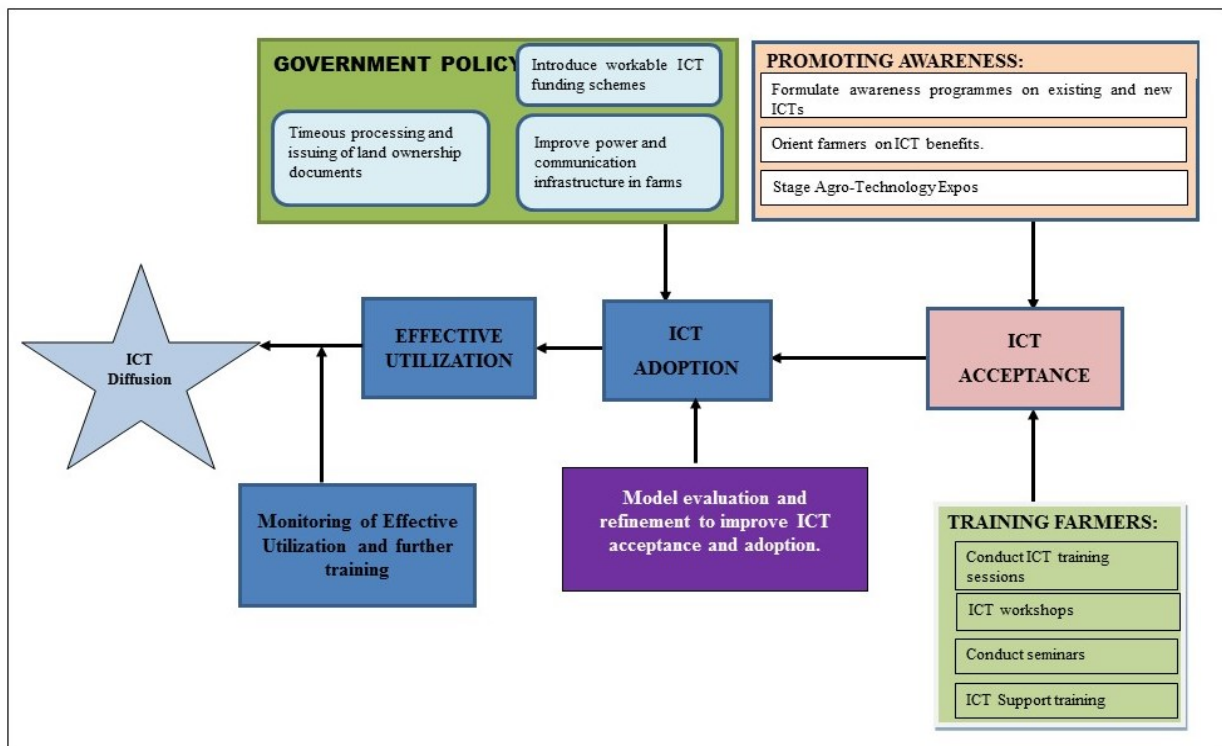


Figure 6: Model after Review

From the proposed model, it can be deduced that there are three major components which are government policy, training and awareness campaigns that can improve the level of ICT adoption and effective utilization in commercial agriculture in Zimbabwe. The policy will stand a great chance in encouraging new commercial farmers in Zimbabwe to consider adopting ICTs in their agricultural activities. Training and awareness will likely improve acceptance which will subsequently influence ICT adoption. The effective utilisation of ICTs after adoption should to be monitored in order to identify training needs of farmers. ICT adoption will finally result in ICT diffusion where most farmers will be utilising agro-technology for farming activities. However, the effort for ICT adoption needs to be evaluated and review the three components where necessary. The next section discusses the model in the context of the research questions.

5.2 Model in the context of research questions

Zimbabwe has experienced an emotional turbulent land reform period at the beginning of the 21st century which culminated in the new black commercial farmers coming on board. These new commercial farmers in Zimbabwe have invested in ICTs that support agricultural activities. This research was carried out at a time when agriculture, once a key contributor to the Gross Domestic Product (GDP) of Zimbabwe was in the doldrums. The aim of the paper was to design a model for adoption and effective utilisation of ICTs by new commercial farmers in Zimbabwe a developing country in Sub-Saharan Africa.

- a) *To what extent has the new commercial farmers in Zimbabwe invested in ICTs that support agricultural activities?*

In the context of this question the findings have shown that new commercial farmers in Zimbabwe have partially adopted ICTs while some farmers have not adopted at all. To address this problem, the model shows that for adoption of ICTs to be widespread there is need for acceptance to happen. New commercial farmers in Zimbabwe can only invest their money in ICTs that support their agricultural activities if they have realised the benefits of such ICT instruments. In light of that the model shows two components that critically feed the ICT acceptance. The model shows there is need to carry promotional campaigns like road shows to promote ICT use by the farmers. The model further shows the need to educate and train farmers on how to use those ICTs. The sole aim is create awareness and promote ICT acceptance by these new commercial farmers.

- b) *What are the need areas of ICT investment in new commercial agriculture in Zimbabwe?*

While this question is critical to this research, the model does not reflect specific need areas of agricultural activities that require ICT investments. Generally, the model shows the need for creating an awareness which can lead to the adoption of ICT in every aspect of agricultural activities.

- c) *Which features are necessary for the development of a model for ICT adoption in commercial agriculture?*

The developed model has all to do with the third research question. The research identified the necessary features for the model for adoption and effective utilisation of ICTs in agriculture. The model shows the critical components that makes a valuable model for successful adoption and effective utilisation of ICTs in commercial agriculture activities. The model addresses the issue of acceptance first before talking about adoption. The model highlights the need to create awareness first. Farmers must have an appreciation of the value of ICTs to their agricultural activities. After acceptance, farmers can commit their financial resources in the ICTs for agriculture. The model indicates that the adoption of the ICTs is also moderated by Government policies on farming. The policies can encourage or discourage the adoption of ICTs in agriculture. After successful adoption of ICTs in agriculture has occurred, the model then highlight the need for effective utilisation of those ICTs. The successful utilisation will result in the diffusion of ICTs among most farmers.

5.3 Limitations of the research and model

This research was conducted at a time when Zimbabwe was experiencing the worst economic crisis in decades. There are perennial liquidity problems in the economy at that time, a dysfunctional manufacturing industry, virtual absence of the market for agricultural produce. The research process has its own limitations; hence future research can be done when the economy is in a different state. The research was also done after the contentious land reform program. Participants were new farmers with very little or no experience of farming at all.

5.4 Future work

The study concludes that there is indeed low level of adoption of ICT in commercial agriculture as evidenced by the results of tests conducted to ascertain the level of adoption. We developed a model based on literature review and practical field research. We believe that our model may be used for the adoption and effective utilisation of ICTs in agriculture in a developing context, especially countries that have gone through agrarian reforms. Future researchers can also employ different approaches to do this research like participatory research, grounded theory approach. Future researchers can also analyse the model and focus on developing a strategy that can be used for acceptance, adoption and effective utilization of specific ICTs for sustainable development of agriculture. Zimbabwe boasts of the highest literacy rate which is second to none in Africa (Musungwini 2016). The country boasts of a well educated population hence this model was developed in this context. As a result of that, our model has some shortcomings when it comes to a context where the populace may not be educated. We believe future researchers can look at the model and criticize it, disapprove or extend on it. Most importantly, we believe that policy makers and new commercial farmers in Zimbabwe and other developing countries can be guided by the model in the adoption of ICTs in their agriculture activities.

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