

COVID-19, Armed Conflict and ICTs Adoption Decisions. Insights from Cameroonian Farmers

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ABSTRACT

It is common knowledge that adopting information and communication technologies -ICTs can significantly enhance agricultural performance. However, their adoption and usage in African agriculture remains disappointing. This study assesses ICTs adoption rates and adoption determinants among Cameroonian farmers. A structured questionnaire was used to collect data from a random sample of 120 farmers in two selected sites highly hit by COVID 19 and an on-going armed conflict in Cameroon's North West region. Data collected and analysed using SPSS, version 25.0 revealed an overall ICTs adoption rate of 87.5%: 3 times higher than the national average. Experience with ICTs was the lone variable that significantly influenced ICTs adoption at 95% confidence interval ($\beta=0.414$, $p=0.034$). However, the age of the farmer ($\beta=0.122$, $P=0.073$), ICTs usage in last six months ($\beta=-4$, 316, $p=0.072$), farm size ($\beta=1.132$, $p=0.06$), and farmers income ($\beta=-5.22$, $p=0.072$) significantly influenced ICTs adoption only at the 10 percent level. Based on these results we conclude that high ICT adoption rates by farmers in the study is most likely an adaptation strategy to the combined negative lockdown and ghost town effects of COVID 19 and the on-going armed conflict respectively; which create incentives for ICTs adoption. We recommend ICT awareness campaigns, experience-sharing and capacity building as key activities to sustain ICT adoption and eventually stem future dis-adoption rates. Research thrust on the positive impacts of perceived negative events like COVID 19 and armed conflicts especially in Africa is encouraged.

Keywords: ICTs adoption, Farmers, determinants, COVID 19, armed conflict, Cameroon

INTRODUCTION

Information and communication technologies (ICTs) play a significant role in all aspects of modern society. ICTs have changed communication patterns, facilitate information search, modified business transactions and work processes (World Bank 2008; El Bilali and Allahyari 2018), especially with the advent of COVID 19. Broadly speaking, Information and

Communication Technology (ICT) is a blanket term encompassing all the technologies and services involved in computing, data management, telecommunications provision, and internet, facilitating the transmission and reception of information of all kind (El Bilali and Allahyari 2018). ICTs permeate all aspects of contemporary society providing newer, better, and quicker ways for people to interact, learn and communicate (World Bank 2008; Olayemi et al. 2020).

Adopting ICTs in agriculture can enhance farm performance, for instance by facilitate access to agricultural research findings, and Market and Information Services – MIS (World Bank 2008, El Bilali and Allahyari 2018). Adoption is the extent to which a new technology is accepted and used for a desired purpose. Adoption rates increase when the adopter has full information about a new technology and its potential (Feder and Umali 1993).

Agriculture in Africa is one of the sectors where appropriation of ICTs is still far below expectation, even though, it is the main source of livelihood for the majority of the rural population (Kimengsi et al. 2020). The agricultural sector accounts for almost two-thirds of the total employment and about 75% of Africa's domestic trade World (Bank 2008). With the majority of the rural population depending on agriculture for their livelihoods, promoting the growth and development of the sector, enhancing resilience and upgrading competitive capacity are central to Africa's development (Awazi and Ouanndt, 2021).

One way to enhance growth, development and competitiveness of the agriculture sector is through the effective and sustained utilization of Information and Communication Technologies (ICTs). Existing evidence suggests that ICTs have been a significant contributor to the growth and socio-economic development in countries and sectors where they are highly adopted (FAO 2017; Stan et al. 2019; Olayemi et al. 2020). The effective integration of ICTs in the agricultural sector in the United and European countries led to tremendous improvement in agriculture value chain efficiency and productivity. For instance, traceability technologies such as block chain, and radio frequency identification (RFID) has enabled transparency and efficiency throughout the food chain through tracking and tracing of food from farm to fork, rendering traceability any food related incidents (FAO 2017). El Bilali and Allahyari (2018) assert that ICT-based innovations can improve rural livelihoods and empower farmers in developing counties by enhancing their connectivity and increasing access to accurate and timely agriculture information. In contrast, agricultural transformation through digitalization is yet to take place at an acceptable rate in Africa: a continent in which over 70% of its population depends on agriculture for livelihoods (Ayim et al. 2022). Only 33 million of over 384 million farmers (8.6%) in Africa are currently reached by digital applications; projected to reach 200 million by 2030 (Stan et al, 2019; Ayim et al. 2022). These diversified applications target advisory and information services, market linkages, financial access, and supply chain management, with advisory and information service dominating the market (El Bilali and Allahyari, 2018). ICT applications come handy in multiple settings, such as targeting advisory and information services, market linkages, financial access, and supply chain management. Advisory and information services dominate the ICT market (Stan et al. 2019). Given the potential contribution of ICTs to modernizing African agriculture, and the availability of these technologies, slow adoption raises some key questions:

Which ICT technologies are preferred by farmers? Which factors explain why some farmers adopt certain ICTs while others do not? This study attempts to provide preliminary answers by drawing on the experiences of farmers in North Western Cameroon. The study area is unique

given its double experience of COVID 19 and armed conflict: both contextual events that create difficulty for regular farm transactions, thereby creating incentive for farmers to adopt available ICTs.

Statement of the Problem

Cameroon is one of the African countries where ICTs adoption rates are still very low. For instance, the internet penetration rate that was lower than 1% in 2006 grew at the rate of 14% per annum between 2007 and 2011, and 19% between 2012 and 2017. These growth rates are far lower than the 32% internet penetration in Africa (Bakehe et al. 2017; Fambeu 2021). Low penetration has been attributed to high cost of internet, for which Cameroon ranks 152 out of 169 countries. Overall, only 6% of Cameroonians have access to internet. The industry has the highest number of users, while farmers are among those with the least access (Fambeu 2021). Overall the ICT adoption rate in Cameroon is among the lowest in central Africa (Bakehe et al. 2017; Fambeu 2021). Meanwhile, the agricultural sector – largely subsistence, is a life wire for 40% of Cameroon's population, employs up to 70% of the workforce, contributes over 40% to the GDP, and accounts for 30% of export revenues (World Bank 2013; Nji and Engwali 2019; Kimengsi et al. 2020).

The economy of the North West region – fondly called the break basket of Cameroon is typically agrarian: over 80% of the workforce is employed in agricultural sectors, and close to 85% depend on it for their livelihoods (Nji and Engwali 2019). Since 2016, this region has been engulfed by a socio-political crisis orchestrated by street demonstrations by lawyers and teachers against the obligatory use of the French language in courts and schools in the (2) predominantly English-speaking regions in Cameroon (Lazar 2019; Bang and Balgah 2022). The protests met with stiff resistance from the regular military, eventually breeding secessionist tendencies. In spite of government efforts to promote dialogue, the crisis escalated into armed conflict in 2017. Frequent confrontations between armed secessionists and the regular military have led to heightened insecurity and lockdowns (ghost towns) imposed by separatists in Cameroon's North West and South West ('Anglophone') Regions. Lockdowns disrupt access to farm inputs, labour supply, and access to finance and product markets for farmers in these regions (Shillie et al. 2022).

In addition to the armed conflict, the North West is one of the regions highest-hit with the COVID 19 pandemic in Cameroon, with a fatality rate of 4.1%, compared to a national average of about 1.6% (OCHA 2022). Responses to high COVID 19 incidences have included lockdowns, restricted movements and gatherings, which aggravate the situation of farmers in the region, who already suffer from the effects of the on-going socio-political crisis-cum armed conflict (Bang and Balgah, 2022). Under such circumstances, one will expect farmers in these regions to rapidly adopt ICT options such as internet, TV, Facebook, twitter and different marketing apps, as alternatives to circumvent the effects of the crises. ICT adoption can facilitate understanding market price trends (FAO, 2017); access to farm inputs and support services (Stan et al., 2019), timely access to market information, weather changes (Olayemi et al. 2020); and secure financial transactions for farmers in these two regions. Such a paradigm has been recently reported for instance in Indonesia, where social media usage increased in response to impulsive buying imposed by COVID 19 restrictions (Hanifer et al. 2022).

Despite all these advantages, not every farmer in the study region adopted an ICT option for agricultural purposes. Who adopts what and why, therefore becoming relevant issues for research, in order to better unleash the potentials in agriculture in this troubled regions of Cameroon. To narrow this knowledge gap, this study identifies ICTs adopted by farmers and the factors influencing adoption decisions in two communities in the North West Region of Cameroon.

LITERATURE REVIEW

The impacts of ICTs adoption in agriculture

Agriculture is, without doubt, an information-sensitive sector, as timely information is crucial for making effective farm decisions (Opara 2008; Deloitte 2012). Theoretically, information is a public good that should be made widely and freely available to all (Ferris et al. 2008; Pimentel and Francisco 2009). In practice, information asymmetry persists. Farmers need to make efforts to access information, for instance by connecting to appropriate information sources (Manfre and Nordehn 2014). In this sense, Oladele (2011) declares that ICTs have become the major gateway for agricultural information for multiple stakeholders, including extension agents, researchers and farmers. In summary, ICTs tools can potentially transform agricultural systems, and improve the performance of farm enterprises in both developed and developing countries (Gwaka 2017).

The use of ICTs in the global market is more wide spread in the developed than in developing countries (Fountas et al. 2007). For instance, 75% percent of farmers in Denmark and 50% in the United States engage in precision agricultural practices, and regularly draw on internet sources to limit uncertainties in farm decision making (Bagchi and Udo 2007; Fountas et al. 2007; Ayim et al. 2022). Adopting ICTs in Africa is increasing, though at a slower than expected pace (Bartholomew et al. 2009). Many African countries increasingly appropriate modern ICTs like emails, internet, computers, World Wide Web (www), and mobile phones; while consolidating traditional ones like radio and TVs in day-to-day transactions (Farrell 2007; Bakehe et al. 2017). Comparatively, over 50% of grassroots projects in India have been using modern ICTs for the benefit of rural communities for over 2 decades (Rao 2004). Nevertheless, there is a growing consensus (also among farmers in Africa) that increased adoption of ICTs can create (farm) business opportunities in the short run, and develop and sustain then in the long run by improving timely information exchange and improving (farmers') decision making capacity, market access and service delivery for improved productivity and livelihoods improvement (Rathgeber and Adera 2000; Bartholomew et al. 2009; Fambeu 2021), especially where external conditions (COVID 19 and an armed conflict) favour disintegration of physical input and output markets, as is currently the case in the North West region of Cameroon. This article explores the ICT choices of farmers in the study site, and reasons why some farmers adopt ICTs and not all in the study area.

Determinants of farmers' decision to adopt Information and Communication Technologies

Compatibility between technology and target groups can foster development (Voogt and Knezek 2008; Ngochembo et al. 2022). Consequently, ICTs adoption will be higher when they align to, and are compatible with farmers' needs (Rao, 2004). However, many other factors influence farmers' decisions to adopt ICTs or not. Windrum and Berranger (2002) highlight an array of ICTs adoption influencing factors among farmers to include (1) farmers characteristics,

such as farm size and yields; (2) system characteristics such as availability and access to ICTs services; and (3) internal and external characteristics of farmers, including education, experience and incomes. Yang (2005) appends perceived knowledge, gender, adoption experience, and the need to access Market Information to the aforementioned.

Dholakia and Kshetri (2004) contend that experience in using ICTs, perceived competition, specialized applications required for given ICTs components and costs like power, subscription and repairs do influence adoption of ICTs for farmers. Like Windrum and Berranger (2002), they classify these determinants into internal and external factors. Internal factors include farmer characteristics such as farm size and age, past experience in using ICTs, attitude towards ICTs and farming objectives. Dholakia and Kshetri (2004) report positive perception towards using ICTs, longer past experience in using ICTs, age and a larger farm size as positively associated with ICTs adoption in farm-based small and medium enterprises. External influencing factors include existence of infrastructure like roads and ICTs service providers and the cost of internet access (Fambeu 2021). Other factors such as the state of infrastructure, reliability of ICTs service providers and favorable agricultural macroeconomic and national policy on (agricultural) commodities, taxation, agricultural licenses have been reported to influence ICT adoption among farmers and other stakeholders in Cameroon (Bakehe et al. 2017; Fambeu 2021).

The value and intensity of action by each farmer participating in agricultural activities using ICT rises with increasing level of adoption of ICTs that makes individuals more efficient and cost-effective (Dholakia and Kshetri 2004). Increased participation of individual farmers in ICTs also comes with increased network coverage infrastructure in such locations of households (Saloner and Shepard 1995; Dholakia and Kshetri 2004). Because of high variation in ICTs forms, there is high variation in ICTs' adoption by farmers. This adoption depends on how useful a certain ICTs format is perceived especially considering its usage, ease and availability in farming/business purposes (Galloway and Mochrie 2005; Jacobs and Herselman 2006). Other ICT adoption determinants identified include impulsive buying imperatives (Hanifer et al. 2022), remoteness of farmer's area, government support to establishment of ICTs, awareness programs about ICTs, farmers' confidence in use of ICTs, costs of using ICTs services, objective of farmers to use ICTs, general importance of ICTs, and farmers' literacy ability (Windrum and Berranger 2002; Dholakia and Kshetri 2004; Ngochembo et al. 2022). Jacobs and Herselman (2006) argue that the perceived lack of need for ICTs by has a strong negative influence on farmers' non adoption of ICTs and related services. This poor perception stems from language problems experienced in using ICTs, attitude barriers like cultural beliefs, limited awareness about ICT benefits, and lack of government support. Failure to adopt ICTs is also attributed to long hours taken to access information from source for instance when downloading using (poor) internet, high subscription fees, and lack of precise content required for specific farmers' needs. This leads to a poor motivation for farmers to adopt ICTs.

In spite of the existence of common determinants across many case studies (such as age, experience and farmers' perception), the concise review presented here seems to suggest that by and large, factors influencing ICT adoption are context-specific. In fact, a recent systematic review of 799 papers on ICT adoption in Africa by Ayim et al. (2022) revealed that effective adoption of ICT services by farmers is hampered by inappropriate ICT policies, poor infrastructure, and low levels of user skills. However, none of these studies was carried out in

a context marred by perverse events such as COVID19 or an armed conflict. The present contribution narrows this knowledge gap, with a case study from farmers in North West Cameroon, whose context is characterized by a combination of high COVID 19 prevalence and a prolonged socio-political crisis. This study draws on the technology acceptance model theory, briefly explained in the next section.

THEORETICAL FRAMEWORK

The Technology Acceptance Model Theory

The Technology Acceptance Model Theory (TAMT) appropriated for this study was originally formulated to facilitate understanding of why people accept or reject information systems (IS) or other technologies (Davis 1989; Davis et al. 1989). TAMT is a modification or extension of Theory of Reasoned Action (TRM) - a fundamental theory in the behavioural sciences (Ajzen, Fishbein and Atomic, 1980); used in modelling intentions to accept the information technology (Davis 1989). Originally, TAMT explained the “causal link between beliefs (usefulness of an information system (IS) and the ease of using the IS) and user attitudes, intentions, and actual ICTs adoption behaviour (Davis et al. 1989, p.983). As depicted in Figure 1, TAMT was applied to explain and predict user acceptance of ICTs based on measures taken after a brief period of interaction with the system (Osei et al. 2016; Msoffe and Ngulube 2017). Much in line with the theories of planned behaviour (Ajzen 1991)¹, and prospect motivation theory (Wuepper et al. 2020; Buchenrieder et al. 2021), farmer acceptance of ICTs is hypothesized as an outcome of his or her intention to accept or reject it. The intention, in turn, is determined by the farmer’s attitude towards the information system and his or her perceptions concerning its usefulness. Attitudes are formed from beliefs a person\farmer holds about ICTs usage in agriculture (Davis 1989).

¹ Both planned behavior and prospective motivation are psycho-cognitive theories that seek to explain how human decisions are made. The planned behavior theory holds that behavior is determined by intentions, attitudes and subjective norms. Prospect motivation theory rests on the cognitive assumption that actors value gains than losses, and if they have a choice, they will choose the option that optimizes gain and minimizes losses. For further discussion see for instance Azjen 1991; and Wuepper et al., 2020.

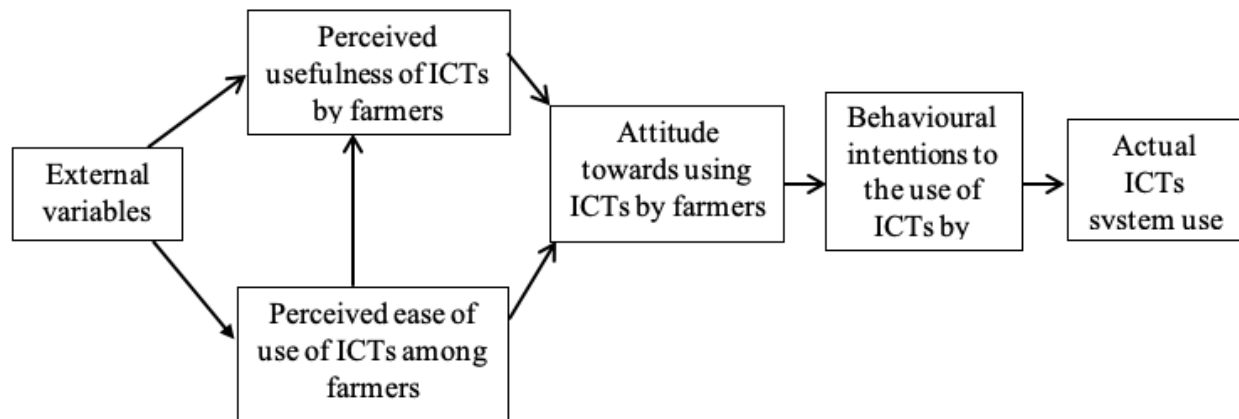


Fig. 1 Technological Acceptance Model Theory
Source: Adapted from Davis et al. (1989)

Beliefs in TAMT consist of the targeted ICTs users' perceptions of its usefulness and its ease of use. External variables such as the task, user/farmer characteristics, political influences, organizational factors, and development process, are expected to influence Technology Acceptance behaviour indirectly by affecting beliefs, attitudes or intentions (Kim and Crowston 2011). Given the context specificity of beliefs, attitudes and intentions (Ajzen 1991), technology acceptance scholars have emphasized the importance of the individual user perspective in ICT adoption research, encouraging Information Systems scholars to identify factors that influence individual users' adoption and use of ICTs for each single case study (Jacobs and Herselman 2006; Kim and Crowston 2011). Farmers within contiguous farming systems face similar challenges or are affected by the same factors. The differentiating factor between adopters (users) or non-adopters (non-users) of ICTs can therefore be elucidated by the manner in which various external influences faced by all, are handled within an internal frame of preference by adopters (Ayim et al. 2022). This case study in which farmers operate in an environment characterized by shocks from COVID 19 and armed conflicts therefore lends itself as a unique field laboratory from which lessons pertaining to ICTs adoption can be drawn. The key variables specified in the TAMT framework to influence the adoption of ICTs among farmers are summarized in figure 1. Personal or farmer-specific features (independent or explanatory variables) combine with instrumental variables such as cost, convenience, availability and timeliness, ease of use, infrastructure, network connection; farming system, and intervening variables such as need, knowledge and perception to define attitudes towards ICTs. These attitudes shape behavioural intentions in the short-run and adoption decision in the long run (Davis et al. 1989). As echoed by Msuya et al. (2014), the framework's flexibility allows researchers to include context-specific (personal and environmental) factors, which could be functional in different permutations and directions. The combined influences multiple factors determine whether farmers are aware or use ICTs, and how they assess and selectively use information available through ICTs (Davis, 1989; Peansupap and Walker 2005; Hill et al. 2008; Msuya et al. 2014). Farmers' participation or non-participation in ICTs therefore defines which type of information they access, and eventual welfare outcomes such as financial inclusion, market integration poverty alleviation among farmers (Msuya et al. 2014; Ayim et al. 2022). We adopt this theory in our study due to its appropriateness to model determinants of

ICT adoption by farmers, and the capacity to adapt and select variables of relevance to the context.

MATERIALS AND METHODS

The study site

The study was carried out in Mezam division in the North West Region (NWR) of Cameroon. The NWR has a population of about 2.3 million inhabitants, over 80% of them relying on subsistence agriculture (Nji and Engwali 2019). The climate in this region marked by two distinct seasons which are the dry and the rainy seasons. The rainy season is usually from around mid-march to mid-October and sometimes extends to November (Balgah et al. 2016). The rainfall ranges between 2000mm to 2500mm per annum and highest amounts are recorded in July and August. Agriculture is the main employer in the region (Nji and Engwali 2019).

Two study sites in Mezam: Bamenda I and III Sub-Divisions (Figure 1) were selected based on two key criteria: (1) they host the highest number of COVID 19 cases – therefore agricultural (and other) activities have suffered greatly from COVID 19 protective measures; (2) they are destinations for internally displaced persons in the region due to relative security, compared to many rural areas in the region. Both reasons theoretically provide motivation for farmers in these study sites to adopt ICTs.

Research design

A cross sectional survey design and mixed methods approach was used to collect quantitative and qualitative data from a random sample of farmers in the two study sites. The adopted mixed methods approach combined the use of a structured questionnaire and observations. Mixed methods enabled the research team understanding of the current level of adoption of ICTs among farmers in the study site, while observing ICTs and their visible impacts on adopters.

Population and sampling

The population for the study were active livestock, crop and vegetable farmers who are members of common initiative groups, and reside/have farming units within Bamenda I and III Sub-Divisions. Both purposive and random sampling techniques were used in this study. Two subdivisions: Bamenda I and Bamenda III were purposively selected for the study, as they exhibited acceptable security conditions that could permit research to be carried out with farmers. Through the municipal councils in the study area, registered farmers' common initiatives groups were identified. Only registered groups were retained in order to minimize the effects of extraneous variables, such as access to extension services. In a follow up step, only registered farming groups existing on or before 2016 when the crises erupted were retained. This was necessary to ensure that groups were functioning before the crises. 33% and 50% registered farming groups were purposively targeted per subdivision respectively. However, the final selection was random, using the draw method from a list of registered farming groups obtained from the various council offices. 120 active farmers were randomly selected for the survey (65 out of 93 members, for groups in Bamenda I, and 55 out of 83 members from 2 groups in Bamenda III). An active member was one that had a farm at the time of interview. All other active farmers not selected were kept in replacement lists and new random draws were done whenever a pre-selected farmer was unavoidably absent or declined to respond to the questions posed by the research team.

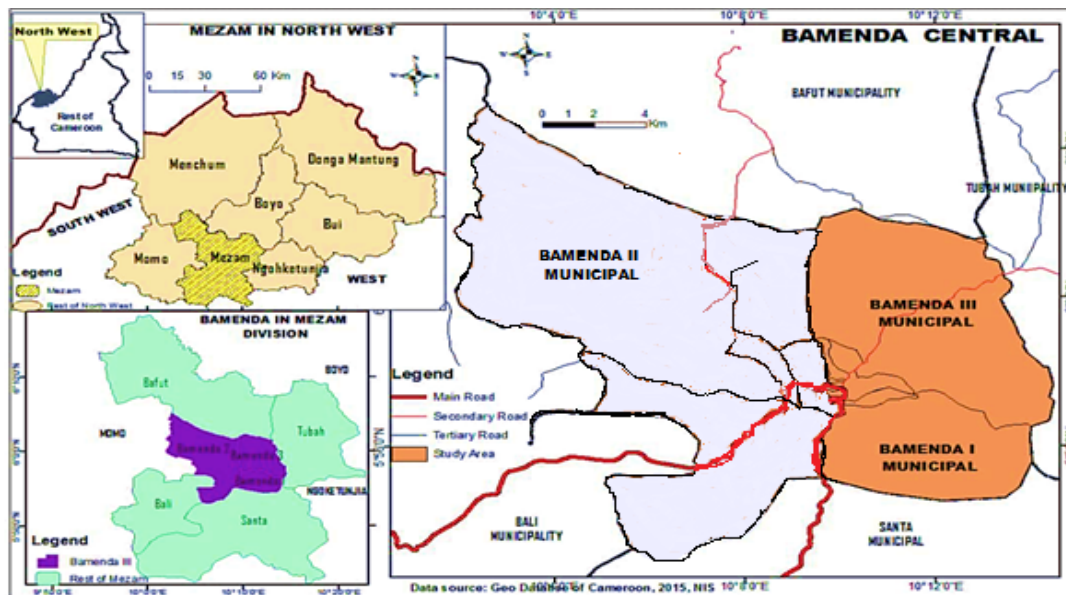


Fig. 2 Location of Bamenda I and Bamenda III municipalities in the North West Region Cameroon

Source: Geo-database, NIS Yaounde (2021)

Data collection, analysis and presentation

A structured questionnaire was developed and used to collect primary data. The questionnaire mainly consisted of closed-ended questions with variables drawn from existing theoretical and empirical literature on ICTs adoption (Davis et al. 1989; Vukmirović 2008; Simeunović and Russo 2010; Jacobs and Herselman 2006; Kim and Crowston 2011; Ayim et al. 2022). As the elaboration of the questionnaire was seen as an interactive process, several pre-tests were conducted. The first draft of the questionnaire was extensively pretested with 10 agricultural experts and research assistants at the Bamenda I and Bamenda III councils, and issues on lack of clarity, duplications and contradictions were identified. A second draft was pretested with presidents of all farmers' common initiative groups, and a final adjustment made, before printing and multiplication for data collection. Copies of the printed questionnaire were administered by the principal researcher and 4 trained enumerators (bachelor's degree holders). Interviews took place at the respondents' homes and group meeting venues, where observations could also be made on the ICTs adopted (or not).

The data collected were analysed using Statistical Package for Social Sciences for windows (SPSS), version 25.0 and Microsoft Excel 2013. Descriptive statistics (means, standard deviations, percentages or frequencies) – presented in the forms of charts and tables were used to describe the sample population, while inferential statistics (binary regression analysis) was performed to identify key determinants for farmers' ICTs adoption decisions in the study sites.

Analytical framework and Model Specification

Binary responses were elicited during the cross-sectional survey, given the categorical nature of farmers' decisions to adopt ICT or not. Following Bogdan and Biklen (1998), when introduced to ICTs technologies, farmers have only two options: to adopt or decline. This decision can be influenced by multiple factors such as age, prior ICT experience, education, utility preferences, and perceptions among others. In this study, a positive decision (that is to

adopt) took a unit value (1) and negative one (not to adopt) a zero (0) v., given differing resources, education, aims and utility preferences hence positive decisions took a unit value and negatives a zero value, (Tambi et al. 1999; Chunrong and Norton 2003).

Specifications of the model

Considering that farmers may adopt several components of ICTs for accessing production and market-related information, adoption of ICTs by farmers in this case was categorized into four prominent ICT components namely, Mobile phone, Pay phone, computers, I-pads and others (such as any of CD-ROM, TV, World Wide Web, or Internet/Email). Marginal effects are used to interpret the impact of a change in the independent variable on the dependent variable (Greene 2002).

The logit model

Data was analysed using the logit model. The mathematical formula for the logit model used in this study is expressed in equation (1) below:

$$Y = \text{logit}(P) = \ln\left(\frac{p}{1-p}\right) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots \dots \beta_{17} X_{17} + \epsilon \quad 1$$

Where;

P = Probability that household chooses to use the ICTs components

1-P = Probability that household does not chooses to use the ICTs components

In the logistic model (equation 2), the notations $\beta_1, \beta_2, \dots, \beta_{17}$ (generally termed as β) denote the slope coefficients of the explanatory variables $X_1, X_2, \dots, X_{17}$ (generally termed as X) and α is the intercept term (constant), ϵ = Error term.

Specifically, the Explanatory Variables used in the logistic model are;

X_1 = Sex of the farmer

X_2 = Length of time using ICTs

X_3 = Age of farmer

X_4 = Perceptions on ICTs

X_5 = Educational level of farmer

X_6 = Use of ICTs in last six months

X_7 = Number of plots owned by farmer

X_8 = Farm sizes

X_9 = Level of income of farmer

X_{10} = Past experience in ICTs usage

X_{11} = Government tax policies on ICTs use

X_{12} = Farming objectives

X_{13} = Access to ICTs services

X_{14} = Power failure

X_{15} = Inadequate ICTs knowledge

X_{16} = Inability of government to deliver adequate ICTs knowledge

X_{17} = Poor network

Justification for the use of the Logistic Model

Logistic regression models were preferred due to the fact that farmers are generally operating in similar environments (in this case marred by COVID 19 and a socio-political crisis), and their (household) characteristics generally similar (Balgah et al., 2016). As already mentioned, the topical literature was used as a source of the explanatory variables likely to influence the

adoption of ICTs by farmers (Peansupap and Walker 2005; Hill et al. 2008; Vukmirović et al. 2008; Simeunović and Russo 2010; Ayim et al. 2022).

For instance, Hill et al. (2008) found age to be negatively associated with the likelihood of internet engagement. Vukmirović et al. (2008) contend that monthly subscription costs were negatively associated with the likelihood to use internet. Donner (2007) found farming objectives to be positively associated with ICTs usage by farmers. Simeunović and Russo (2010) contend that education was an important aspect in the adoption and use of ICTs by farmers. Wolcott et al., (2008) suggested that experience gained in using ICTs when ICTs are integrated into daily systems of work was positively associated with use of ICTs. Peansupap and Walker (2005) found that a positive feeling for use of ICTs was positively associated with expansion in ICT use and adoption by farmers. These results informed the questionnaire, and subsequently the models used in this study.

Specification of the Multinomial Regression Model

Based on the fact that adopters had several choices of ICTs components that they used with several factors influencing their choices; and that the types of ICTs largely adopted by farmers for agricultural activities vary, a multinomial logistic model is used to analyse the data. The model estimated two equations concurrently as specified below:

$$\ln\left(\frac{P_s}{P_o}\right) = C_s = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \dots + \alpha_{11} X_{11} + \epsilon_i \quad 2$$

$$\ln\left(\frac{P_r}{P_o}\right) = C_r = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_{11} X_{11} + Y_i \quad 3$$

Where:

P_o = Probability that household chooses to use both the modern and the olden components

P_s = Probability that house chooses the modern of ICT components

P_r = Probability that household chooses the older days of ICT components

C_s = Household opts to use modern alternative (1 if household uses, 0 otherwise)

C_r = Household opts to use olden alternative (1 if household uses, 0 otherwise)

α_0 and β_0 = Intercepts

$\alpha_1 \dots \alpha_{11}$ and $\beta_1 \dots \beta_{11}$ = Parameters to be estimated

$X_1 \dots X_{11}$ = Vectors of Explanatory Variables

Y_i and ϵ_i = Error terms

Specifically, the Explanatory Variables in the multinomial logistic model are;

X_1 = Knowledge of Existence of ICTs, 1 if yes, 0, otherwise (KN)

X_2 = Usage of ICTs in agriculture, 1 if for agriculture, 0, otherwise (UA)

X_3 = Types of ICTs that are most commonly used by farmers, measured as the modern types and old type (TMCUF)

X_4 = Family size, measured in number of persons per household (FS)

X_5 = Agricultural status, measured as temporal and as permanent (AS)

X_6 = Main source of income, measured as from agricultural produced and as from non-agricultural produced (MSI)

X_7 = Used of mobile phone, measured as per the respondent responses (UMP)

X_8 = Household income, measured in France CFA (HIC)

X_9 = Land framed in the previous farming season, measured in hectares (LAND)

X_{10} = Level of risk of ICTs equipment been stolen, measured in terms of lack of ownership over the equipment because it stolen by someone else (RES)

X_{11} = High cost maintaining ICTs equipment, measured in terms of price per (HCM)

Justification for the use of the Multinomial Logistic Model for choice analysis

The multinomial logistic model (MNL) has been used to identify factors influencing households' choice of particular components of ICTs gadgets. Enables examination of decisions across more than two available category options for choice; thus, permitting the determination of choice probabilities for each option (Madalla 1983). However, for unbiased and consistent parameter estimates, the MNL assumes impendence of irrelevant alternatives. In more detail, the independence of irrelevant alternatives assumption demands that the probability of choosing a certain ICTs component for market information by a given adopting household is independent from the probability of choice another component (Greene 2002).

RESULTS AND DISCUSSION

Socio-economic Characteristics of Farmers

The sample comprises more of female than male ($\approx 65\%$ and 35% respectively). Male farmers were less likely to adopt the use of ICTs compared to female farmers, who as mothers are primarily responsible for household food security. This women's gender role is likely to create disincentives for marketing of farm products, as most farm outputs might be consumed at household level. By implication, women might demonstrate more disinterest in adopting ICTs in agricultural transactions than men, who are more integrated into the market.

The Majority of respondents are involved in animal production (33%) followed by crop production (close to 29%), and vegetable production (12.5%); while 26% of them practicing mix farming. These statistics were confirmed through observations in the field during the data collection phase. The respondents affirm majority of these farms are operated at subsistence level, using crude tools like hand cutlasses and hoes, with little or no skilled labour; supporting previous findings in the research region (Balgah et al. 2016; Kimengsi et al. 2020). Given that subsistence farming provides disincentives for adoption of ICTs (Hill et al. 2008), a high ICTs adoption rates will be attributed to a favorable adoption environment, stimulated by the exigencies of COVID 19 and the armed conflict, particularly movement restrictions and ghost towns respectively.

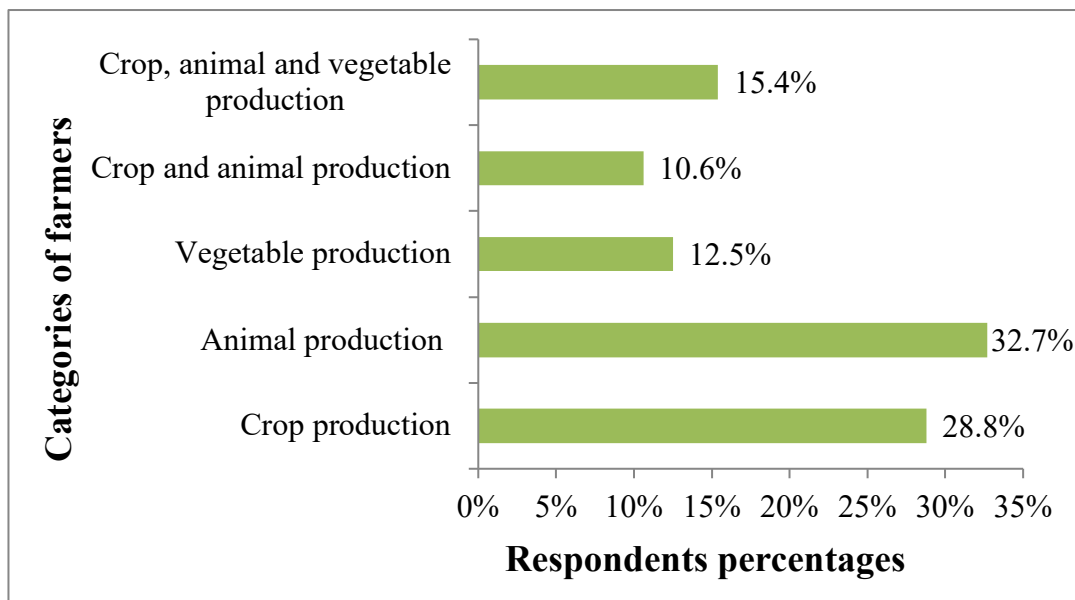


Fig. 3 Categorization of farmers by agricultural activity

The majority of sampled farmers (over 44%), had only primary school education. Close to 31% had completed secondary school, 5.8% had participated in vocational training and 11.5% had attained university level of education. Overall, 56% have attained above primary education. Education level is positively correlated with the adoption of ICTs especially at the production and at the marketing levels (Galloway and Mochrie 2005; Simeunović and Russo 2010). Based on this contention, we expect a low adoption rate in our case study. Almost 73% of respondents are married while 17.5% are still single. According to Food and Agricultural Organisation (2015) marital status is said to influence farm practice. Moreover, marital status has implication on social organization and economic activities such as agricultural and resource management as well as ICTs adoption. Jordan et al. (2012) also mentioned that married couples are likely to adopt ICTs than the single farmers.

Almost 55% of the interviewed farmers are fully involved in agriculture; while 45% partially rely on agriculture for livelihoods. While such results indicate the importance of diversification as a livelihood strategy among Cameroonian farmers (Kimengsi et al., 2020); agriculture makes a contribution to the livelihoods of all interviewees. This represents 20 percentage points higher than the 80% of the farmers: a statistic already reported in many studies in the North West Region of Cameroon (Balgah et al. 2016; Nji and Engwali 2019; Kimengsi et al. 2020; Awazi and Quandt 2021). This is probably because the study purposively targeted farmers who are members of registered farming groups.

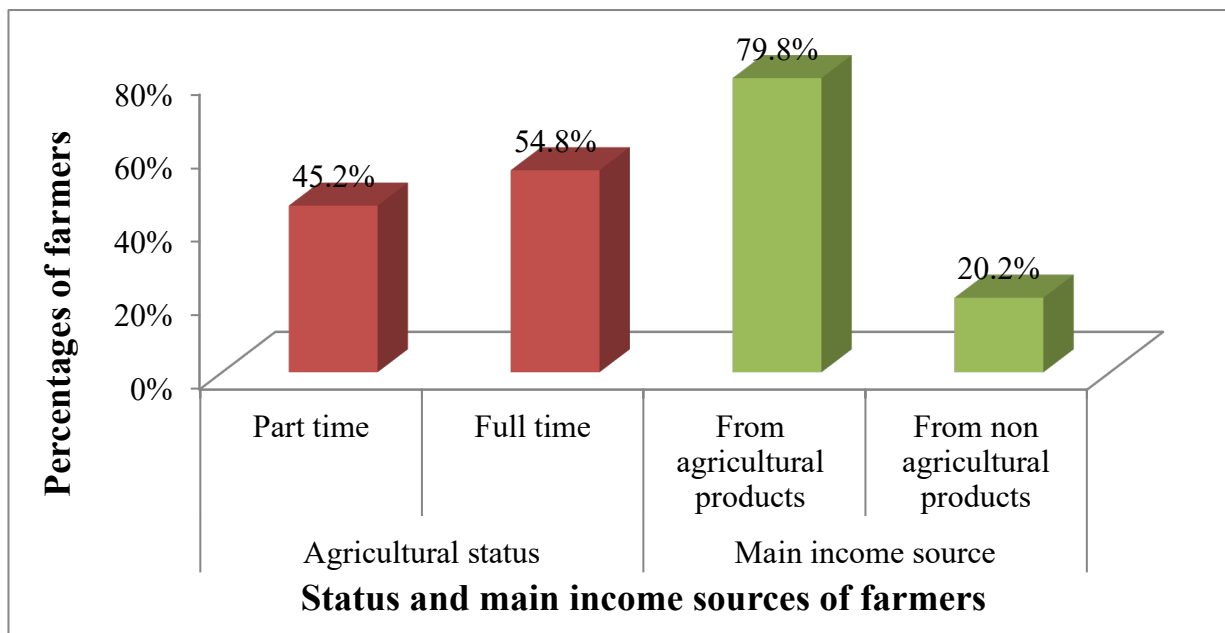


Fig. 4 Status and main income source of farmers

About 51% of the farmers evaluated their income levels to be low, 30.0% to be medium with only about 19.2% evaluating their incomes to be high. Income levels in the study area were also statistically significantly different between low, medium and high income levels ($p = 0.01$). That the majority of the farmers had low incomes level as compared to that with medium and high-income levels corroborates previous conclusions that poverty rates among farmers in Cameroon is higher than the national average (Balgah and Fonteh 2019). Meanwhile, income level is a key driver for adopting and regularly ICTs (Voogt and Knezek 2008; Ngochembo et al. 2022). Given that subjective ratings place 51% of interviewed farmers as, poor, it would seem logical to attribute higher adoption rates to pressures imposed by the COVID 19 pandemic and the on-going armed conflict.

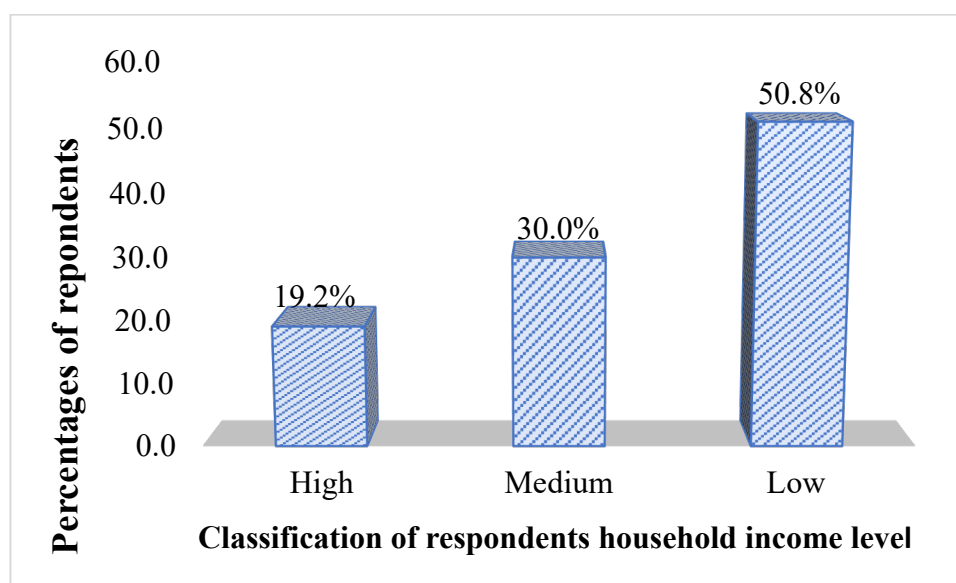


Fig. 5 Farmer's evaluation of household income

Additional descriptive statistics are summarized on table 1. The youngest farmer interviewed was 20 years while the oldest was 78 years. The mean age of the farmers was 50 years (50.17 ± 13.39 years) which is 4 years less than the life expectancy ratio of 54 years in Cameroon (World Bank 2013; Balgah et al. 2016). Farm household sizes ranged from 1 to 18 with a mean of 7 members. The mean farm size was 12 hectares, with a minimum of 1 and a maximum of 1000 hectares. Similarly, the mean number of plots owned by farmers was 2, with a minimum of 1 and a maximum of 5 plots. Theoretically, farmers with larger farm sizes and more plots are likely to adopt ICTs (Galloway and Mochrie 2005).

Table 1 Age, household size, farm size, and number of plots owned by farmers

	Minimum	Maximum	Mean		Std. Deviation
Variables	Statistic	Statistic	Statistic	Std. Error	Statistic
Age of farmer/years	20	78	41.19	1.227	12.514
Household size	1	18	7	0.308	3
Farm size/ha	1	1000	12.4204	9.82746	99.253
Number of plots owed	1	5.0	2	.1369	2

The descriptive statistics reveals quite some disparity between the sampled farmers, making further analysis of the determinants of ICTs adoption quite exciting. This aspect is presented and discussed in the next section.

ICTs adoption rates and types

The study reveals that 87.5% of interviewed farmers adopted and used ICTs services particularly for agricultural production and marketing, while 12.5% of the farmers did not. The major technology adopted was android – based mobile phones, which permitted farmers to explore services such as text and whatsapp messaging, whatsapp and facebook for advertising and marketing, and mobile money services. Almost 80% of them used internet services regularly, mostly choosing pre-paid options that are cheaper to access. These activities were observed during data collection. Overall, the adoption rates are far higher than national and African standards: Only 6% of Cameroonians have regular access to internet; and the internet penetration rate for Africa is only 32% (Bakehe et al. 2017; Fambeu 2021). An overwhelming majority of interviewed farmers (95%) acknowledged that ICTs facilitated agricultural transactions, particularly access to farm inputs and output markets, while 5% did not. Given that ICTs adoption in Africa is lowest among farmers (Msuya et al. 2014; Ayim et al. 2022), we attribute this rather extraordinary adoption rates in the studied communities to the capacity and desire of farmers in the troubled North West region of Cameroon to adapt to the joint effects from COVID 19 and armed conflict.

Determinants of ICTs adoption by farmers in the study area

A binary regression analysis was conducted to identify the contribution of each variable to the use of ICTs in agriculture. The dependent variable (Use of ICTs) took 1 for yes and 0 otherwise. Seventeen variables (sex of farmer, length of time using ICTs, age of farmer, perception on ICTs to agriculture, educational level, ICTs usage in last six months, number of plots owed, farm size, level of income, past experience in ICTs usage, government policy of little or no tax, farming objective, availability and access to ICTs services, power failure, inadequate ICTs knowledge,

inability of government to deliver adequate ICTs knowledge to farmers, and poor network) were retained for the binary regression analysis. From table 2 it is observed that our regression model explains 60.4% of the variables that influence the use of ICTs in agriculture in the study area (Nagelkerke R Square = 0.604). Therefore, and following Nyanda, 2015, Haji et al., 2016, and Zemach (2018), our model is satisfactory, even if it does not fully account for all the variables or characteristics that influence the use of ICTs in agriculture in the study area.

Table 2 Regression Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	33.343 ^a	0.302	0.604

Table 3 presents the regression statistics on factors influencing the adoption of ICTs by farmers in the study sample. The results show that 08 variables: sex of farmer ($\beta = 1.435$), length of time using ICTs ($\beta = 0.414$), number of plots owed ($\beta = 1.132$), farm size ($\beta = 0.062$), past experience in ICTs usage ($\beta = 0.896$), farming objective ($\beta = 1.147$), availability and access to ICTs services ($\beta = 0.903$), and government policy of little or no tax ($\beta = 1.112$) made positive contributions towards the adoption of ICTs in agriculture in the area. These results align with previous findings in the topical literature (Donner (2007; Wolcott et al., (2008; Simeunović & Russo, 2010).

On the other hand, 11 variables: age of farmer ($\beta = -0.122$), farmers perception on ICTs to agriculture ($\beta = -20.777$), educational level ($\beta = -0.992$), ICTs usage in last six months ($\beta = -4.316$), level of income ($\beta = -5.22$), high cost of maintenance ($\beta = -0.921$), power failure ($\beta = -0.727$), risk of ICTs equipment's being stolen ($\beta = -0.354$), inability of government to deliver adequate ICT knowledge to farmers ($\beta = -0.439$) inadequate ICTs knowledge ($\beta = -0.474$), and poor network ($\beta = -2.077$) did not lend themselves as crucial variables promoting the adoption of ICTs in agriculture in the area. While these results are generally in line with theory (Davis et al., 1989), and empirical findings (Kim and Crowston 2011; Msuya et al. 2014), they need to be reflected upon from a contextual perspective.

It is strange that a mean age of 41 years creates disincentives for adopting ICTs in agriculture. This is likely due to negative perceptions, orchestrated for instance by frequent internet disruptions and power failures, and low levels of income as a result of market disruptions (e.g. through prolonged ghost towns imposed by separatists); increased theft and harassment as fallouts of the prolonged crisis; and increasing household expenditures on preventive, curative other government-imposed measures to combat COVID-19 (e.g. purchase of soap and water for washing of hands, face masks, and treatment/ burial expenditures). Such trends have been reported elsewhere in Africa (see for instance Bisson and Hambelton (2020) for West Africa; and SPAU (2020) for Kenya).

Only previous experience with using ICTs was significant at the 5% level ($\beta=0.44$, $P=0.034$); aligning with the contentions of previous scholars (Msuya et al. 2014; Ayim et al. 2020) that experience is a crucial determinant for ICTs adoption and usage for farmers in Africa. This has to be understood within the backdrop of no clear government effort to promote ICTs in agriculture in Cameroon. However, the age of farmer ($\beta = -0.122$, $p = 0.073$) was also another

significant element in ICTs adoption and usage by farmers, ICTs usage in last six months ($\beta = -4.316$, $p = 0.072$), number of plots owned ($\beta = 1.132$, $p = 0.06$) and the level of income of the farmers ($\beta = -5.22$, $p = 0.072$), were significant at 10% level. While it is logical that older farmers tend not to adopt farm innovations (Ngochembo et al. 2022), not using ICTs for long periods creates incentives for disadoption. Number of plots: an appropriate proxy for farm size in the study area (Balgah et al. 2016) positively correlates with adopting ICTs. This result aligns with previous contentions that farm size and therefore the farm objective (subsistence or market-oriented) can influence ICTs adoption rates by farmers (Dholakia and Kshetri, 2004; Galloway and Mochrie, 2005; Jacobs and Herselman, 2006).

Table 3: Determinants of ICTs adoption in agriculture by farmers

	B	S.E.	Wald	Df	Sig.	Exp(B)
Sex of farmer	1.435	1.331	1.161	18	0.281	4.199
Length of time using ICT	0.414	0.195	4.496	18	0.034	1.514
Age of farmer	-0.122	0.068	3.215	18	0.073	0.886
Perception on ICT	-20.777	5.532	0.000	18	0.999	0.0001
Educational level	-0.992	0.858	1.336	18	0.248	0.371
ICTs usage in last six months	-4.316	2.403	3.227	18	0.072	0.013
Number of plots owned	1.132	0.729	2.411	18	0.06	3.103
Farm size	0.062	0.072	0.757	18	0.384	1.064
Level of income	-5.220	2.906	3.227	18	0.072	0.005
Past experience in ICTs usage	0.896	1.125	0.635	18	0.425	2.451
Government tax policy	1.112	0.837	1.212	18	0.271	0.398
Farming objective	1.147	0.995	1.327	18	0.249	3.148
Access to ICTs services	0.903	0.957	0.891	18	0.345	2.468
Power failure	-0.727	0.894	0.662	18	0.416	0.483
Risk of being stolen	-0.354	0.863	0.169	18	0.681	0.702
Inadequate ICTs knowledge	-0.474	0.872	0.295	18	0.587	1.606
Inability of government to deliver adequate ICTs knowledge	-0.439	0.712	0.379	18	0.538	0.645
High cost of maintenance	-0.921	0.901	1.523	18	0.217	3.041
Poor network	-2.077	1.975	1.106	18	0.293	0.125
Constant	34.131	15012.535	0.000	18	0.998	6.651

Note: the dependent variable is 0.414 and 1.132

CONCLUSION AND RECOMMENDATIONS

That adopting ICTs can facilitate agricultural activities is well known in the topical literature. However, why only few African farmers adopt and use ICTs is still debatable. We contribute to the debate by assessing the factors influencing farmers' adoption decisions and choices of a random sample of 120 farmers from two study sites in Mezam Division of the North West region of Cameroon, using a structured questionnaire and observation. The study sites were selected due to its unique experience of COVID 19 cum armed conflict by farmers: both events which negatively affect agricultural activities, while providing motivation for adopting ICTs as an efficient adaptation strategy. Collected data analysed using SPSS, version 25.0. The results revealed that 87.5% of the respondents use at least one ICTs service in agricultural transactions, while 12.5% of the farmers do not. We attribute this higher-than-national-average adoption rate to adequate response by farmers to the double crises hitting hard on inhabitants of the region.

Experience with ICTs was the only variable that significantly influenced ICTs adoption at 95% confidence interval level ($p = 0.034$), in line with contentions in the topical literature (Ayim et al. 2022). This experience, we argue has been gained over the 6 years duration of the armed conflict; and strengthened by COVID 19 prevention measures, particularly movement restrictions. However, with the exception of farm income; the age of the farmer, ICTs usage in last six months and farm size positively and significantly influenced ICTs adoption only at the 10 percent level. These results mirror contentions in the topical literature. Based on these results we make a number of conclusions. First, the ICT adoption rates by farmers in the study sites are likely motivated by their willingness to adapt to the negative effects of COVID 19 and the persisting armed conflicts. Secondly, experience with ICTs remains a key determinant for adopting ICTs by farmers in Cameroon.

Based on the above results, some key conclusions were made. Firstly, given the relevance of experience to ICT adoption by the studied farmers, we recommend regular awareness, experience sharing and capacity building activities, especially among younger farmers, while prioritizing large farmers with potentials for market integration. Secondly the government of Cameroon and service providers should create an enabling ICT environment and provide excellent services, to downscale disadoption rates among farmers. Meanwhile more studies should be carried in other regions and countries in Africa to confirm the role of the vulnerable context marred by COVID 19 and socio-political crisis on the ICTs adoption rate of farmers in Cameroon. Unlike many studies, our research raises the need to explore the positive effects of undesirable events such as COVID 19 pandemic and conflicts in Africa, which until now are often assumed to have only negative consequences.

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