

Digital Economy: ICT Framework for Farming Information Dissemination and Management in DRC

Frederick Kamba Kabangu¹; Wonganombe Otshakoto²; Ntiama Junior³; Justin MBIMBI⁴; Kengo Jospin⁵; Zola Joris⁶
Teaching Assistant and Researcher^{1,2,3,4,5,6}

Department of Computer Science & Business Management, Haute Ecole de Commerce,
259, libération, Gombe, Kinshasa,

Jacob NGWABA⁷

Ministry of Post and Telecommunication (DR CONGO),
1009, boulevard du 30 Juin, kinshasa, The Republic
Democratic of Congo

Joseph NGWABA⁸

Senior lecturer and Researcher,
Department of Computer Science and Business
Management, University of Kinshasa

Abstract:- The agricultural sector is increasingly becoming both knowledge-intensive and techno-intensive. Generally speaking, agriculture sector is dynamic, farmers actively seek timely, accurate and relevant information to keep up with daily challenges. These challenges will significantly grow as a result of climate change that causes changing rainfall patterns and extreme weather events including, more frequent droughts and floods. ICTs has been instrumental for information broadcasting to farmers. Policy makers, extension practitioners, scholars and development agencies including, NGOs are advocating ICTs as a tool to foster smallholder farmers productivity, efficiency and performance through information including, new variety of seeds, fertilizer, livestock breeds, emerging diseases, vaccines, farming technologies, use of pesticides as well as market information. In addition, they enable large hub of know-how and sharing opportunity between agriculturalists, investors and entrepreneurs. Most African countries are essentially agrarian economies and agriculture turns out to be livelihoods of hundreds of millions households as well as a key driver of the economic development. However, most farmers in the Democratic Republic of Congo – especially smallholder farmers – perform below their potential. Many governments and scholars have developed innovative solutions related agricultural practice. The challenge is to enable information dissemination by large numbers of smallholder farmers. The study aims to propose a framework and policies for farmers to share information through ICTs. It used both quantitative and qualitative methods. The case study design is applied where empirical data was collected using questionnaires, interviews, documents analysis, and group discussions with farmer groups. Based on the research objectives, it was discovered that ICT policies is quasi-inexistent in agricultural sector. The government provides no agricultural information to farmers. In terms of ICT access, 36% of farmers own a telephone. 58% use basic feature phone while 42% of the respondents use smartphone. 66% of farmers would like to be provided information by a mobile phone. 63 % of farmers would prefer to have information in video format while 34 % in

audio format. 95% of respondent strongly agree that ICT can improve their farming condition.

Keywords:- ICT, Developing Countries, Democratic Republic of Congo, Farming, E-Government.

I. INTRODUCTION

Due to the growing of mobile, wireless, and Internet industries, ICTs have taken place in poor small scale farms and in their daily activities (World Bank, 2011). They turn out to be a fast, reliable and accurate vector of information sharing and know-how among farmers and improve their competitive position and fostering their cohesion as producer groups. As a body, they can decide what and when to plant, how to cultivate and harvest when and where to market the produce at a given price, etc. (Venkatesh, J. et al., 2010). This can have tremendous impact on agricultural productivity and promote farmers' integration with the market and stakeholders as well as members of the value-chain including, consumers, agricultural input manufacturers, extension service providers, banks, researchers, policymakers, among others.

The 2015 Human Development Index report ranks the DRC 176 out of 187 countries, with the population living under abject poverty while the country comprises 80 million hectares of arable with 10 million under cultivation including rivers and lakes. Most of the population lives in conditions of moderate to serious food insecurity and child malnutrition is widespread. The 2019 International Fund for Agriculture Development report showed that about 70 percent of population is engaged in agriculture, mostly they lack access to new technology causing them to operate well below their potential allowing only for subsistence agriculture. There is a urgent need to expand land under cultivation to leapfrog food security and reach sustainable and equitable economic development.

Applying ICTs to improve information dissemination could increase production and expand land cultivation, while increasing household income and create a more stable and resilient communities. The agricultural sector is complex and knowledge-intensive. Exposing farmers to timely, accurate and consumable information will have positive incident in their production and marketing decisions. The present paper makes an attempt to: (i) review some of the ICT initiatives made under the Government, (ii) to map farmers information needs and understand their socio-cultural behavior in general (iii) identify agricultural information required by small scale farmers, (iv) to determine the best ICT tools to use in disseminating agricultural information to farmers specifically, (v) develop ICT based framework that fits and adopted locally and (vi) recommend policy measures to use ICTs for effective information dissemination.

A. Benefits of ICT Enabled Agriculture

The benefits of ICTs in agriculture sector is undeniable as it can serve as a levy to achieve agricultural growth by enhancing productivity. Agriculture controls the GDP of most developing countries to great extent. Following are some major outcomes of ICTs enabled agriculture:

- To foster ownership and techno-entrepreneurship in agriculture sector;
- To help smallholder farmers increase their production;
- To increase public investment in agriculture.
- Enable a hub of agriculture stakeholders where agriculture related information updates and know-how are shared;
- To use innovative practices through science and technology.
- Enhanced food security and support rural to livelihoods.
- Poverty alleviation through modern agriculture.
- Broaden perspective of local production at a global scale.

B. Challenges of ICTs

Nwafor, Christopher and Ugochukwu, M.(2020), Abdulrahman Saidu et al.(2017), Ayim C. et al.(2022) exhaustively identified numerous issues and impeding developing to fully reap the benefits of ICT application in agriculture sector including, absence of political will, Regulation and Policy Challenges, lack of basic ICT skills, High illiteracy rate, poor internet infrastructure, inadequate and fluctuation of power supply, inefficiency of institutions, the failures to visit farmers, lack of promotion of the service and training of farmers, insufficient personnel to handle ICT infrastructure, absence of local content of language on internet, lack of harmonization of knowledge, lack of consideration of socio cultural factors when designing policies.

C. Research Questions

Based on the specific objectives, the study addressed the main research questions as follows:

- What are the agricultural information required by small scale farmers?
- What is the appropriate ICT tool and format that can be used to disseminate agricultural information?

II. LITERATURE REVIEW

A. Previous Works

Many scholars and researchers commonly agree on the potential ICTs tools is disrupting agriculture sector through innovative solutions. According to Oladele (2011) ICTs turn out to be a gateway for agricultural information. Gwaka (2017) emphasized that ICTs can ensure prosperity of farm enterprises. Munyua and Adera (2009) think that with modern ICTs, agricultural productivity can grow through information and know-how sharing to rural agricultural communities. Bhalekar et al. (2015) and Deloitte,(2012) asserted that ICT enables self-reliance and effective information and knowledge transfer.

Studies from World Bank and AfDB (2012) have revealed that the application of ICTs in agriculture sector increases productivity and improved farmers income. With information sharing, farmers are able to optimally use agri-inputs to grow healthy produces and access market information to set prices.

A study in Senegal revealed that through the creation of website, smallholder farmers are able to access information on climate-change adaptation (Stat FAO, 2017). In rural Niger, through mobile phones, farmers are able to get agricultural price information (Aker J. & Mbiti I., 2010). Studies from Matto, G. (2018), Lwesya, F. and Kibambila V. (2017) & ,Sikoro, A. (2016) respectively in Malawi, Uganda and Tanzania highlighted that through ICTs farmers were able to access post-harvest related information and courses including, mechanism for pest and disease control, information on weather and applications of fertilizer, market information, which are prominent to improve productivity and alleviate food security. In addition, G R Sinha (2013) advocated that ICT has transformed India's GDP through increased growth and sustainable production of agricultural produces.

In slight contrast, Raphael A et al. (2008) findings point that the methods used in developing mismatch with socio-cultural context since their impact on the grass root population is still very low. He found that policy makers fall within four main categories, those at the ministries' level, at the research institution level, at the district level and at the village level. At each level, the kind of content required is different and also the type and level of technology.

B. Government Initiatives

The agriculture contributes to great extent to livelihood of many Congolese living in the majority in remote area as stated by USAID (2018). These farmers endeavor with limited tools to provide food and nutrition to the country and in turn gets very little support from the government. Most fruitful initiatives in agriculture have been carried out by ONGs, private, Cooperatives societies etc. Many agriculture related project failed as a result of high corruption rate and lack of political will from government authorities. Recently, the government initiated the National Information System for Agriculture and Food Security project in collaboration with World Food Programme. For the very first time, the

government has shown the will to include ICT in agricultural sector for integrated management of agricultural information. If the project can be implemented, it can revolutionize agriculture sector in DRC and create more opportunities as well as foster techno-entrepreneurship. Many other projects have been initiated from government never get implemented as a result of embezzlement, lack of continuity of management after the change of authorities, poor budget allocation. Sustainable policies will require government involvement otherwise any initiative will be in vain. The research concludes that so far, no ICT policy has been implemented in agriculture sector from the government in terms of training and infrastructure.

C. ICT Tools used for Agricultural Information Distribution

Mass media refers to communication channels with the capacity to reach large audience of people often via broadcast media (radio, TV). Unlike mass media, small media refer to communication channels that are produced in a standard format but often distributed onsite or locally (CDs, DVDs, pamphlets, books, recordings, and newspapers). In addition, modern technology including, Mobile phone, internet, the Radio Frequency Identification (RFID), Geographical information system(GIS) , Drones, Artificial Intelligence(AI), etc. have taken agriculture practice to the next level. Furthermore, with the roll out of web 2.0 and technologies embedded into mobile phones have disrupted the way people communicate. Social media like Facebook, WhatsApp, Instagram a, TikTok to name just a few, enable

short-length video recorders, voice, text, image and video information.

D. DRC's Internet Penetration

According to statistica (2022), DRC's internet penetration rate stood at 17.6 percent and they are expected to increase by 3.3 million (+25.4 percent) between 2022 and 2023 (Statistica, 2022). Mobile connections in the DRC were equivalent to 46.9 percent of the total population in January 2022. Thirty-nine percent of households have a mobile telephone and 43% have a radio. 44% of urban households have a television, compared to just 2% of rural households (USAID, 2017).

E. Technological Innovation Adoption Framework

The small scale farmer organizations and their partners may find it challenging to use ICTs in the absence of a supportive framework for the technology (World Bank, 2011). Since most of the small scale farmers use traditional way of getting agricultural information. The change in technologies as well as innovation can make adoption difficult or cause resistance to change if not well applied. Many authors discussed and proposed acceptance frameworks including Rogers (2003), De Marez et al. (2011), Moore and Benbasat (1991), Krishna and Ankaiah (2005). This study opted "Roger's Diffusion of Information" model. He proposed a theory that seeks to explain how, why, and at what rate new ideas and technology spread through cultures as depicted in figure 1.

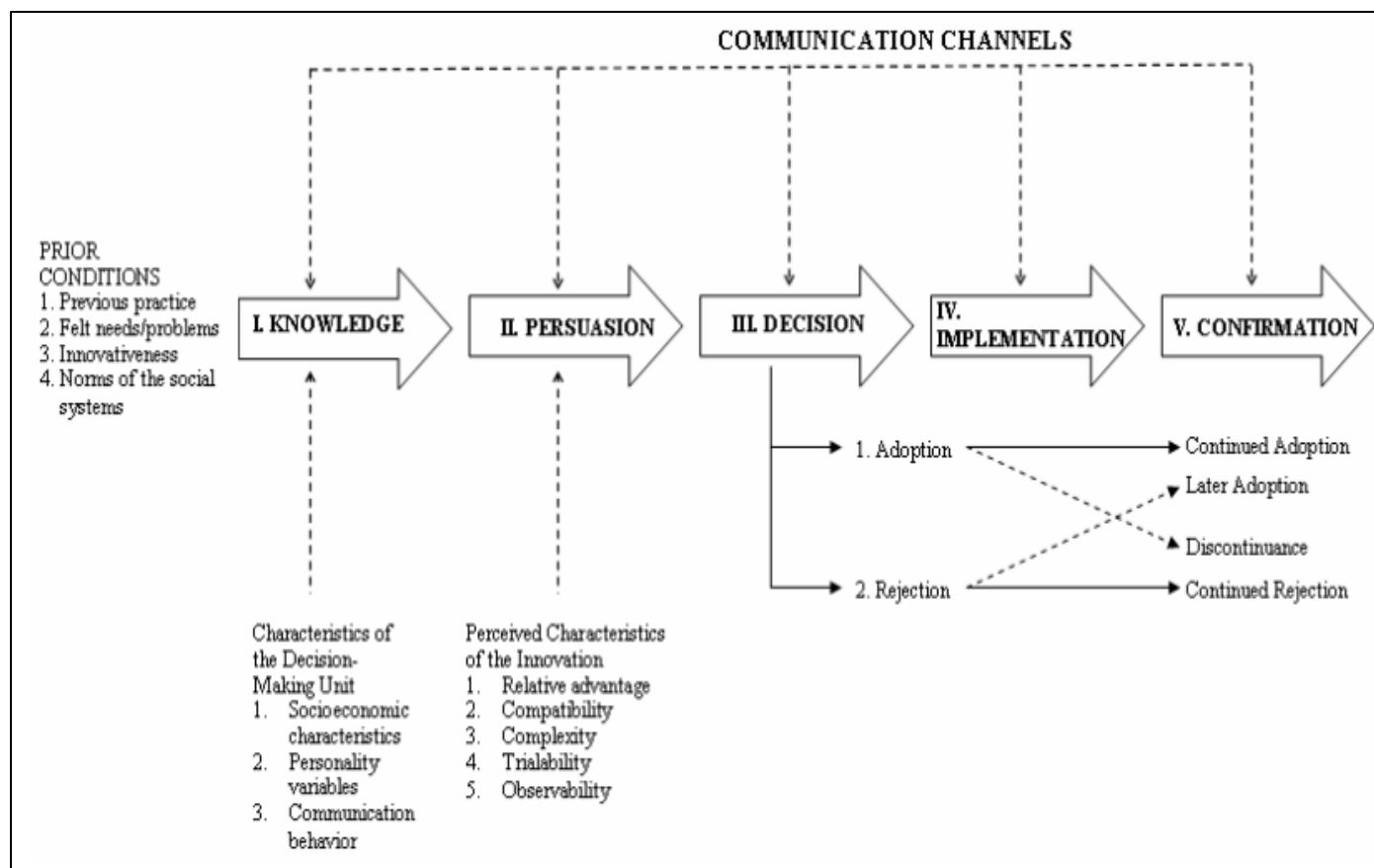


Fig. 1: Technology Adoption Framework (Source: Rogers, 2003).

➤ *Rogers Defined the 5 Stages of the Technological Adoption Process as Follows:*

- **Knowledge:** In this stage emphasizes the individual's exposure to innovation but not yet inspired to find more information.
- **Persuasion:** In this stage the individual is eager about innovation and actively seeks information.
- **Decision:** In this stage the individual decides whether to adopt or reject the innovation. Rogers highlights that it is the most difficult stage to acquire empirical evidence.
- **Implementation:** In this stage, the individual determines the relevancy of the innovation and may seek to know more about it.
- **Confirmation:** the individual makes up his/her mind by adopting the innovation. .

Rogers' diffusion theory provide a popular framework in media and communication studies (Sikoro, 2016). The proposed framework when implemented can enable farmers especially small scale farmers to access and timely deliver agricultural information.

III. METHODOLOGY

A. Research Strategy

The study is using both quantitative and qualitative methods. The case study design is applied where empirical data was collected using questionnaires, interviews, documents analysis, and group discussions with farmer groups. Thus, both qualitative and quantitative approaches were used so as to provide reliable answers to research questions, and in turn propose ICT based framework for the delivery of agricultural information at the local levels. The study design involves the use of questionnaires, analysis of Internet and print documents, and discussions with farmers. A questionnaire (shown in appendix 1) was traditionally distributed to farmers with the help of 15 students and collected at their convenience from June 17th to October 1st, 2022.

B. Study Areas

With the aim to understand agriculture and ICT practices in DRC, a survey was deployed in 2 major provinces including DRC including Kinshasa and Kwilu. The areas of study were selected because most of its population engaged in agriculture specifically small scale farming and therefore, it was convenient for the researcher to get relevant data.

➤ Country Profile

The Democratic Republic of Congo (DRC), about the size of Western Europe, is the largest country in Sub-Saharan Africa (SSA) with over 90 million inhabitants (World bank, 2020). With 80 million hectares of extensive arable land—10million is cultivated, 4 million hectares of irrigated land, and many rivers with important fishery resources, the DRC has the bulk of the major assets needed to become a global agricultural power. The agricultural sector contributes 18 percent of GDP and accounts for over 60 percent of new jobs, the main cash crops include palm oil, coffee, rubber, sugar,

cotton, tea and cocoa. Food crops also include maize, plantains, cassava, groundnuts and rice. However, agricultural production remains substantial. 46.8 percent of population live in urban centres, while 53.2 percent live in rural areas. Over 85% of the active population is under unemployment (USAID, 2017).

➤ Areas of Study

• Kinshasa

Kinshasa is the capital city of the country, with the population estimated over 15 million inhabitants in 2020, 54% living in rural area (World Bank, 2020). Indeed, with the popular looting of 1991 and 1993, many businesses closed their doors. This situation supported by the lack of strong employment policy, the rural exodus and the demographic explosion, has sent many people out of work. This gloomy picture has prompted many families to seek survival solutions through palliative activities, including urban agriculture, including fishing. Market gardening represents the bulk of urban agriculture in Kinshasa (more than 10,000 market gardeners in the city). The main sites are identified by (Jeep, 2010) includes Kingasani ya suka, Echangeur, Camp Mobutu, Camp Kokolo, Camp Lufungula, Funa, Bandal, Limete/ Boulevard Lumumba (between 14th to 4th Street, Industrial side), Kimwenza, Ndjili/ Cecomaf, Kingabwa 1& 2, Mapela, Mikonga, Petro-Congo, Tshuenge, Funa, Lukaya, etc. without forgetting the plot gardens.

• Kwilu

The province of Kwilu includes the five territories of Bagata, Bulungu, Gunugu, Idiofa and Masimanimba and the city of Bandundu which is the capital of the province. With the populaton estimatd over 5.8 million inhabitants in 2017 with 87% living in rural area (World Bank,2020). It has a commercial vocation with the main activity being the marketing of agricultural products that makes it the "breadbasket of Kinshasa" in terms of supply of food products, in particular: maize, groundnuts and palm oil. Agriculture, fishery and livestock husbandry occupy a no less important place with their products which supply the commercial sector in a very small proportion the manufacturing sector.

IV. DISCUSSION OF FINDINGS

A. Key Findings

The finding from the research is summaries in table 1 according the research objectives and research questions. The research has allowed research to gain insight on farmers' behaviors and assess the level of ICT use. In addition, it helped design framework for ICT implementation in agriculture sector in DRC.

Table 1: Research Results

No	Findings
1	Agriculture is practiced in majority by people with low level of education. 45% of respondents hold Primary education while 41% are uneducated.
2	73% of farmers are females.
3	78% of the total 177 respondents said that income from farming is their only source of income.
4	91% of respondents said the agricultural produce is primarily for own use and sale
5	36% of farmers own a telephone. 58% use basic feature phone while 42% of the respondents use smartphone. None of them own a computer.
6	100% of respondents who owns smart phones, use internet. This can highlight that there is a narrow link between smart phone access and Internet usage.
7	The government provides no agricultural information to farmers.
8	66% of farmers would like to be provided information by a mobile phone.
9	64% of farmers would prefer to have information in video format while 25% in audio format and 11% in text format.
10	85% of respondent agree that ICT can improve their farming condition

B. Discussion

➤ *Site Distribution*

Out of the total 177 respondents, 37% are from Kinshasa and 63% from Kwilu as depicted in figure 2. The research targeted people living in rural areas where agriculture is the most practiced. This sample is unbalanced according to the demography of rural population (essentially agrarian) distribution among both region including 87% in Kwilu and 54% in Kinshasa. It is clear that agricultural is more practiced in Kinshasa than Kwilu.

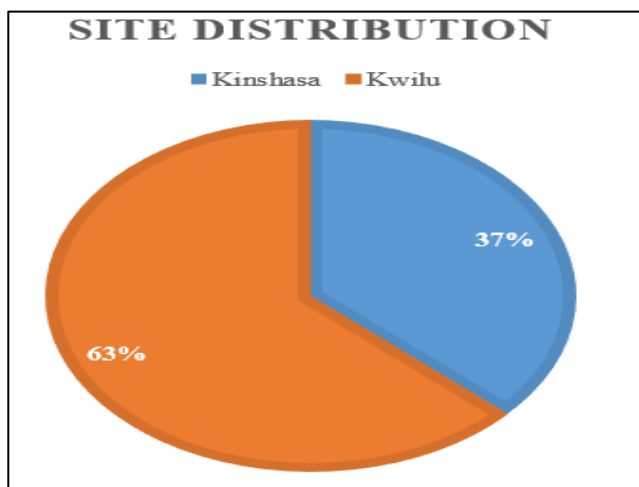


Fig. 2: Sample Distribution

➤ *Age Groups*

The highest part of the answers was in age group between 36-45 years old with 38 percent. The age range between 46-55 is ranked second as shown in figure 3. In a country with high rate of employment, getting salaried job is difficult, so people resort to agriculture for subsistence and sale. Youth represents only 9% of the whole sample. The reason behind this it is difficult for youth to own a farm. Most of young people practice farming under the cover of their parents. In the terrain, it was found that the majority of farmers were aged above 25, youth is more concerned with school but can be helper when it comes to selling produces in the market.

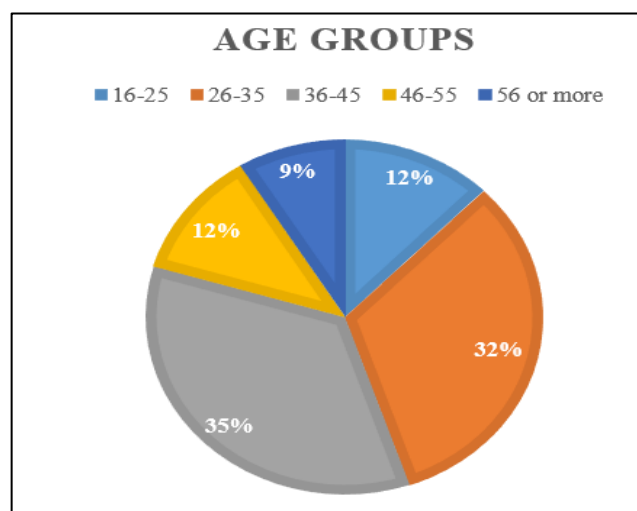


Fig. 3: Age Group Distribution

➤ *Gender Distribution*

27% of respondents surveyed are male and 73% are females as depicted in figure 5. Female labor is the pillar of informal economy in DRC. Women’ employment concentrates on traditional agriculture. The figure meet the finding from JICA(2017) that women provide 70% of the agricultural labour force in DRC. Women entrepreneurship allow many families to survive including nutrition, schooling, healthcare and so on. With little capital, deprived of bank loan, the income is essentially for subsistence without a perspective to scale up. Most of them are widows, divorced, single women. Men are interesting in other activities with ready cash commonly known as “Coop”—which is an informal activity. The Ratio between men and women is 1 to 2 as shown in figure 5.

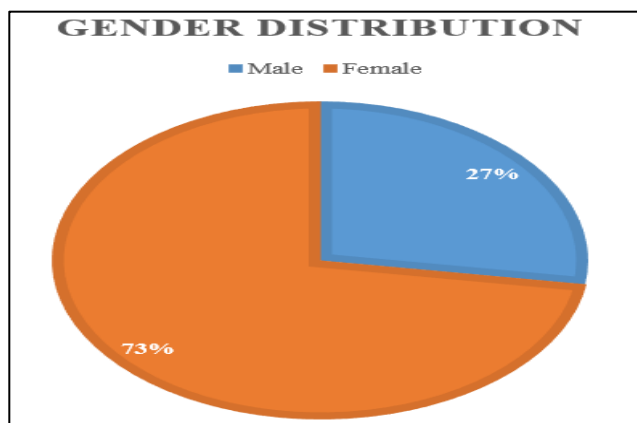


Fig. 4: Gender Distribution

➤ Literacy

Out of 177 respondents, 22% are uneducated which means they either never attended school or completed primary school level. Out of the total respondents said uneducated, 71% are from the province of Kwilu, 29% are from Kinshasa—the capital city. 46% completed secondary school but were unable to complete high school. About 30% of respondents hold high school certificate and 2% holds B.A degree as shown in figure 6. Respectively 90% and 100% of respondents who completed high school and holds a B.A degree are from Kinshasa. These figures highlights that agriculture in DRC is in majority practiced by people with low level of education. Most educated people expect salaried jobs in bureaus to value their diploma as lawyer, cashier, nurse, physicians etc. Being farmer is culturally deemed degrading. This can explain the reason behind 70 million uncultivated land. The 2% of B.A are agricultural engineers who engage in agriculture to apply their academic knowledge but also have made it their primary source income.

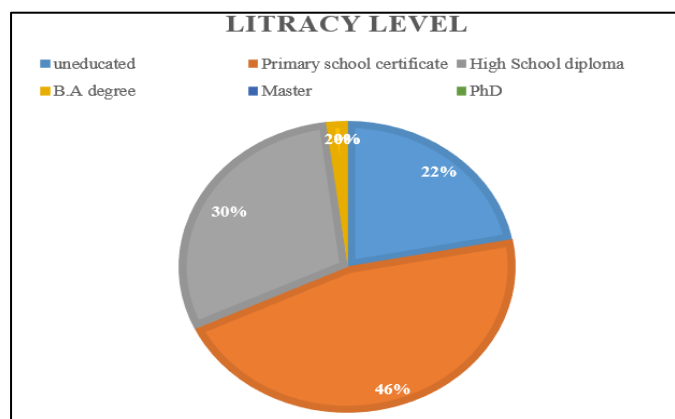


Fig. 5: Literacy among the Population

➤ Agriculture and Household Financial Make-Up

78% of the total 177 respondents said that income from farming is their only source of income. 22% responded that farming is not their only source of income and they have secondary source of income as well. 89% of respondents who said agriculture is the only source of living are from Kwilu. This highlights that unlike Kinshasa and other provinces of the country characterized by diverse economy including mining activities as well as a plethora of both public and

private companies, the province of Kwilu is basically agrarian. There is fewer job opportunity as a result of low penetration of industries supported by poor employment policies. The number of companies present is unable to absorb the majority of labor force as a result of accrued rural exodus to Kinshasa.

➤ Production

91% of respondents said the agricultural produce is primarily for own use and sale, 9% said it is for their own use only. None among respondents practice agriculture for sale only. This data could help in the future role that ICT can play in the management of production ratio between what they should retain for own consumption and what they can sell, where they can sell and what price through a user-friendly applications. In addition, the research discovers that the majority of farmers do not know current trend of market price of their produce as result they sell at a forfeit price often set by middlemen who milk them making their income essentially substantial and maintain them in dire poverty. The role of ICT is to foster farmers’ integration by providing them with real time information enable price discovery.

➤ Farm Sizes

The findings from survey study revealed that, in terms of agricultural land usage and arable areas, 86% of the respondents were found to use five acres or less, 12% of the respondents use ten acres or less, 2% of the respondents were found to use fifteen acres or less. The results show that 98% farmers from Kinshasa carried out their agricultural activities on ten acres or less compared to farmers from Kwilu who go beyond. The farm size of about five or less acres was considered to be small scale farming. This result helped the researcher to know that most of the respondents were small scale farmers.

➤ Access to Device

Out of 177 respondents, only 36% own a telephone. No farmer has a computer. Out of the total respondents who own the device, 58% use basic feature phone while 42% of the respondents use smartphone. Kinshasa is ranked first in terms of smart phone access ratio. In Kinshasa, 32% of 65 respondents use smartphone. In Kwilu out of 112 respondents barely 5% use smartphone. 79% of the 112 respondents from Kwilu are deprived of the device while 37% from Kinshasa. This figure highlights the disparity between both region in terms of ICT access. This can only be alleviated by the government through strong policy implementation regarding ICT access and inclusion.

➤ Internet Access

100% of respondents who owns smart phones said they use internet from their mobile phones. This can highlight that there is a narrow link between smart phone access and Internet usage. If people have smart phone, they are tempted to experience internet. In terms of using internet, social media ranks first with 97% including listening to music and watching videos, while barely 3% said they look for information related to agriculture and related services. Among those who have smart phone, only 1% have agriculture related App installed on their phones. This can

mean that though they have access to technology, they do not take advantage of ICT to improve their knowledge. Hence, training and awareness programme become inevitable.

➤ *Information Source*

Farmers were asked about the source where they frequently get agricultural information. 80% said that they frequently get agriculture related information from other farmers, 12% said seed shops, 6% from nongovernment organizations and 2% from co-operatives and the remaining were not specific. This highlights the majority of farmers resort to other farmers when they are challenged, it is clear that information can fall short or inaccurate. In addition, the Central Government cares less about the development of the agriculture sector as a result of the 70.000 million uncultivated land and the accrued food insecurity. If farmers can be well-informed this will have positive incident in the production hence, the expansion of land cultivation and the economy of the country.

➤ *Information Device*

When asked what ICT tool they would like to be delivered agricultural information, 66% of total respondents said mobile phone, 21% said radio while 13% said TV. It is clear that the mobile phone is chosen by the majority of respondents compared to other media. This figure would help in deciding what ICT tools to include and the way agricultural information would be delivered to farmers in the development of the proposed framework.

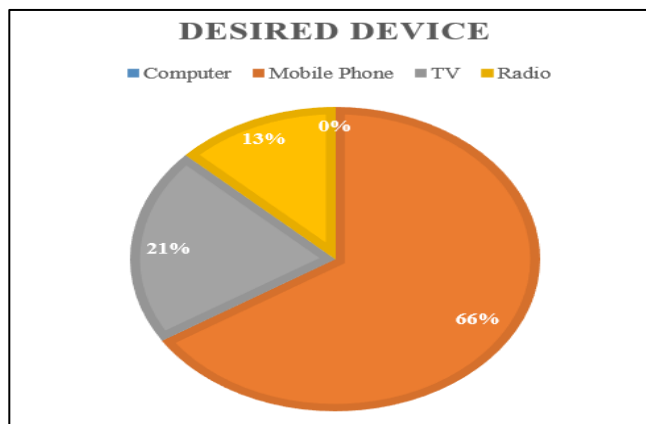


Fig. 6: Desired Device

➤ *Preferred Format of Information*

When participants were asked to provide their views on the most preferred format of information, 64 % said video, 25 % audio, 11 % indicated text. The level of education outbalanced in the choice of the format as reading is a challenge to many for example. Farmers would rather prefer listen to the information and/or have the visual format of the information than a text format compared to the study from Sikoro (2016) who discovered that 61% of farmers preferred text format Tanzania where the majority of farmers according to his study sample were literate. These results helped the researcher to decide on which format was most preferred by farmers based on their social context.

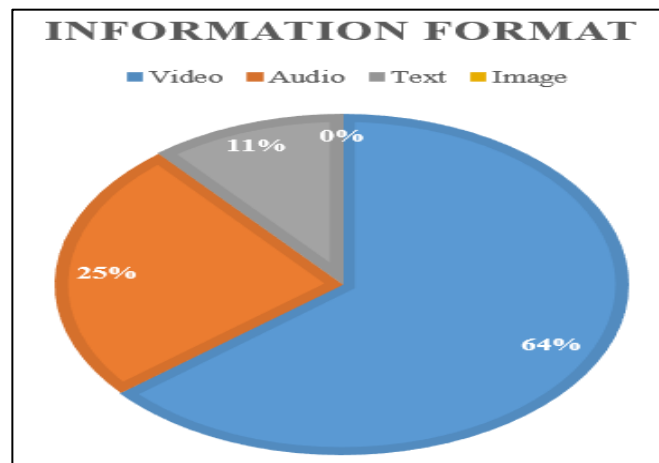


Fig. 7: Information Format

➤ *ICT Awareness*

Only 6% of respondents knows what digital service is. After explaining to some farmers what digital service is, 95% of respondent strongly agree that ICT can improve their farming condition. This is important as to combat cultural resistance to change that characterize ICT adoption especially in developing countries. If people can acknowledge the potential of ICT in their work, this can make adoption easier.

➤ *What they Say they Want*

One of the reasons that hampers productivity is the non-availability of various information on agriculture related issues. Respondents said that weather conditions, livestock epidemic and other related issues take them by surprise as a result they lose much of their produces. According to Meera et al. (2004), in most of the developing countries, much of the agricultural information has been found out of date and irrelevant that is not applicable to small farmers’ needs, leaving such farmers insufficient information or resources to improve their productivity. The timely availability of right information and its proper utilization is crucial. In the purpose of this research, farmers were asked information they would like to be provided and the result is shown in table 2. This finding give insight to research as it reflects the desiderata or every concerns of farmers that they would desperately need solving.

Table 2: Information Wanted by Farmers

No	Information	Repeated Times
1	Soil management	12
2	Quality agri-inputs	14
3	Weather conditions	21
4	Post harvest	19
5	Commodity price	16
6	Disaster risk management system	8
7	Fast land record	10
8	Produce conservation	21
9	Crops pathology	3
10	Livestock pathology	9
11	Epidemics	14
12	Use of fertilizer	11
13	Pesticides	25

C. Adopted Framework

The framework as shown in figure 9 depicts the components of the system based on the findings of the research. The framework was developed purposely in order

to establish the communication between farmers, extension agents, agricultural experts, research centres and community.

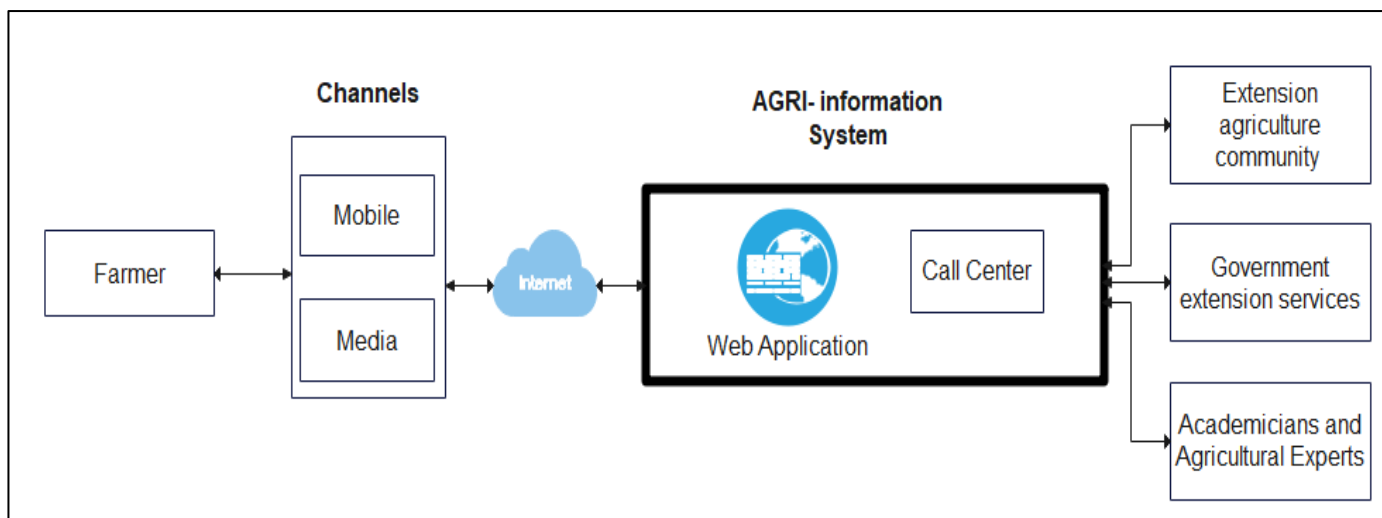


Fig. 8: Adopted ICT Framework

The system is a two-way communication. The farmer can query/receive agricultural information through a web application or make a call where he/she connect to respective agricultural expert. This system integrates web server, application server, mobile server, IVR server and centralized database. Farmers can find videos, audio of related agriculture information and many more.

V. CONCLUSION

The objectives of the research were to review some of the ICT initiatives made under the Government, to assess the information requirement of the farming community and understand their socio-cultural behavior in general, identify agricultural information required by small scale farmers, to determine the best ICT tools to use in disseminating agricultural information to farmers specifically, develop ICT based framework that fits and adopted locally and recommend policy measures to use ICT for efficient and effective dissemination of agricultural related information.

Based on the research objectives, it was discovered that ICT policies in DRC is quasi-inexistent as a result of the lack of political will. The government provides no agricultural information to farmers. The research reveals that agriculture is the primary income resource for 78% of farmers. 91% of farmers practice agriculture primarily for own use and sale. In terms of ICT access, 36% of farmers own a telephone. 58% use basic feature phone while 42% of the respondents use smartphone. 100% of respondents who owns smart phones, use internet. This can highlight that there is a narrow link between smart phone access and Internet usage. 66% of farmers would like to be provided information by a mobile phone. 63 % of farmers would prefer to have information in video format while 34 % in audio format. 95% of respondent strongly agree that ICT can improve their farming condition. This is important as to combat cultural resistance to change

that characterize ICT adoption especially in developing countries. If people can acknowledge the potential of ICT in their work, this can make adoption easier.

This study then concluded that, the mobile phone should be incorporated into the agricultural information system as the main ICT tool that could be used to disseminate agricultural information to the small scale farmers. The main format of information should be video and audio even though other format were also considered in developing proposed framework. The framework was developed purposely in order to establish the communication between farmers, extension agents, agricultural experts, research centres and community heeding the local socio-cultural factors.

RECOMMANDATION AND FURTHER RESEARCH

A. Recommendation

The information dissemination is crucial for the development of agriculture and wellbeing of the farmers. Besides, agriculture is a complex domain that requires necessary competence to face varying challenges including weather condition, soil testing, productivity training, crops pathologies etc. Most farmers did not study agriculture in school or graduate as agricultural engineer. Hence, government, nongovernment, private and co-operatives have a critical role to play by providing farmers state of the art training, giving them real time related agriculture information. ICT become inevitable to enable dissemination of knowledge, market linkages, production management and farming techniques. However, Technologies are no panacea in themselves, and need to be backed by complementary investments in physical infrastructure, including electricity, literacy and underlying policies (Giz,2019). Good ICT infrastructure, adequate skills, good and affordable internet

connectivity, and appropriate policies will enhance implementation of ICT in agriculture in developing countries in general (Munyua and Adera 2009). The following policies and success factors are proposed.

➤ *Infrastructure Challenges can be Overcome*

Some challenges that hinder developing countries to harness the benefit of ICTs include electricity, connectivity, broadband etc. While it's true that circumstances may be harsh and sometimes challenging, there are nowadays all kinds of inventive ways to overcome existing infrastructure barriers including solar power, mini-aggregators, mini VSAT antenna's, pico-projectors, radios, tablets, smartphones with programmers that work offline etc (Giz, 2017).

➤ *Creating Awareness among Farmers*

Proper awareness among farmers on farming activities could help harness implementation of ICT skills for agricultural development. Creating awareness among farmers and other stakeholders on the importance of information and its optimum utilization will help in the development of agriculture and overall wellbeing of the farming community as well as breaking cultural resistance to change that characterize some rural dwellers.

➤ *Fostering the Creation of Agricultural Cooperatives*

Create awareness about the benefits of cooperative societies and how they can be helpful. The role is to formulate research actions targeted at demand, by supporting activities undertaken by peasants with the aim of strengthening the capacities of small producers in the countries in order to generate sufficient cash income from markets, by creating a favorable policy and regulatory environment as well as efficient economic organizations and institutions.

➤ *Delivery Mechanism*

The rural DRC is characterized by poor literacy and poor infrastructure. Finding the appropriate approach and effective channel for information delivery can be challenging. Graphical representation of information like videos, photos can yield better result. Popular media can like television, radio with special programs convey in national languages will help reach the majority of people living in rural communities.

➤ *Stakeholders Synergy*

All public projects stress the importance of partnering. The collaboration between multiple partners with different expertise/competences can be a strong asset in order to bring in knowledge and competences from different perspectives and fastens the process of problem solving, learning as well as creating new cross-links between traditionally separate sectors/entities. Roles, responsibilities and mutual dependencies need to be well defined. In addition, this can allow strong relations with (other) funding agencies or financing institutions in order to leverage sufficient financial means to bring ICT-related innovations to scale; pooling expertise and know-how from different sides, in order to maximize the quality and the impact of the intervention. Partnering with the private sector on ICT development and ICT-deployment is recommended. This involves addressing critical issues to promote innovation uptake, like developing

a viable business plan for innovation uptake through markets and developing the business capacity of partners, clients and end-users (USAID, 2017).

➤ *Training*

Capacity Development through workshops/ training programs is critical to scaling up innovation especially among farmers (World Bank and AfDB, 2012). It is required both to facilitate the innovation process and, after the innovation has been developed, to enable users to take up the innovation in question. But it may also address the capacity related to innovation transfer (e.g. business skills) and the capacity to bring innovation to scale (e.g. lobbying, marketing skills). Further, training programs for government officials is also in order to sensitize them on the needs of farmers takes on greater importance (USAID, 2017).

➤ *Government Involvement*

ICTs can achieve transformative outcome unless government commitment aligns (Tibben, W., 2045). Government intervention is materialized through policies implementations, providing support in the form of infrastructure, finance, subsidies, social and legal security. Furthermore, given the socio-economical context of the population, policies tending to make government to make ICT products affordable and accessible so as to bridge digital divide and foster adoption.

➤ *Farmers Involvement and Profiling in the Design Phase*

To prevent a mismatch between deployed technologies and the ecosystem of the local community, the content of information to be delivered by the system should be developed after thorough assessment of the information needs of the farmers (World Bank and AfDB, 2012). Developers and end users should come up with a consensus on functionalities and the way ICT products can be designed in order to guarantee a large uptake.

➤ *Women Empowerment Strengthening the Involvement of Young People*

All too often, women and young people are disadvantaged, in a variety of ways, in rural areas (Tibben, W., 2015). ICTs have the potential empower young people and women. Women in developing countries are the pillar of the family in terms of smallholder agriculture and they provide 70% of the agricultural labour force. Ensuring women and youth participation in implementation and enhancing their empowerment by supporting their financial independence, while giving due consideration to circumstances and needs unique to women and girls, etc. is crucial. ICT policies should implemented to attract young people to agriculture and help them develop their potential.

B. Suggestion for Further Research

This study primary focused on a framework based on local context. The future research should imply the holistic framework for guiding the development of ICT initiatives that can integrate other geographic locations.

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APPENDIX I: QUESTIONNAIRE

Dear Respondent,

My name is **Joseph NGWABA**, a Master in ICT convergence and Researcher at universities. I am conducting a study on “ICT FRAMEWORK FOR FARMING INFORMATION DISSEMINATION IN DRC”

Definition: Information and communication technologies (ICT) is defined as a set of technological tools and resources including computers, the Internet, live broadcasting technologies (radio, television and webcasting), recorded broadcasting technologies (podcasting, audio and video players, and storage devices) and telephony (fixed or mobile, satellite, visio/video-conferencing, etc.) used to transmit, store, create, share or exchange information (UNESCO, 2020).

The purpose of the study is to identify the needs of small scale farmers and determine the best ICT tools that can be used by them in communicating agricultural information. The ultimate goal being to design a framework of how ICT can facilitate information search and improve communication between agricultural actors. I would like your contribution to this noble task by answering the questions below. Please note that the information you provide will strictly be treated with the outmost confidentiality. The data collected will be used for academic purpose only.

- What is your gender? Male Female
- Where are you from? Kinshasa Kwilu
- What is your age-group?
16-25 26 – 35 36 – 45 46 – 55 56 or more
- What is your highest level of education attained?
Primary level Secondary level Diploma level B.A Master Degree PhD Did not attain(uneducated)
- How many acres do you cultivate?
5 or less 6 – 10 11 – 15 16 – 20 21 or more
- Check the best assertion: Farming is my only source of income I have other sources of income apart from agriculture
- The agricultural produce is: For sale Only Own use and sale Own use
- Which of the following ICT tools do you use in your daily life? (you can tick more than 1 choice)
TV Radio CD/DVD player Telephone Mobile phone Computer
- Do you have a mobile phone?
Yes No
- If yes to question 8, which type of phone do you use?
basic feature phone smart phone
- If you checked “computer” in question 7 or “smart phone” in question 9, do you use internet with?
Yes No
- Do you have some agriculture apps or connected to an online forum related to agriculture?
Yes No
- Based on your environment, which of the following ICT tool would you like to be provided agricultural information ?
Computer Mobile phone Radio TV
- What format of information do you prefer in disseminating agricultural information?
Text Image Audio Video
- What is your source of information used frequently in agricultural activities?
Government officers NGOs Extension workers seed shops Cooperatives
- What type of information would you like to acquire in order to improve your productivity? (you can make more than 1 choice)
Pest management Use of fertilizer Soil improvement Market price Use of pesticide Weather forecast
Financial management Organic farming Others (please specify).....
- Do you know what e-service is? yes No
- Do you think ICT can improve your working conditions?
Strongly agree Agree Neutral Disagree Strongly disagree