

An analysis of information and communication technology policy for agriculture in Mali

Macire Kante

Postdoctoral Fellow, Department of Applied Information Systems, University of Johannesburg, South Africa

mkante@uj.ac.za

Patrick Ndayizigamiye

Senior Lecturer, Department of Applied Information Systems, University of Johannesburg, South Africa

ndayizigamiyep@uj.ac.za

To harness the potential of information and communication technologies (ICTs), developing countries need to develop national ICT policies that serve as frameworks for integrating ICTs in all spheres of society. In the absence of such policies, there is often a lack of coordination of ICT-led interventions which often leads to a waste of resources. Thus, there is always a need to define a national framework for the promotion and application of ICTs in various sectors of a country's economy. The purpose of this study was to analyse the national ICT policy regarding the field of agriculture in Mali. The study adopted the theory of knowledge as its guiding theoretical framework. In addition, this study adopted a qualitative research method as data was collected using policy documents and semi-structured interviews. Data were analysed using the qualitative content analysis (QCA) method with the aid of NVIVO version 12 software. The results showed that Mali had two policy documents that articulated the country's strategy towards the use of ICTs in the agricultural sector. These documents were the Agricultural Orientation Law and the National Strategy for the Development of the Digital Economy. Further examination revealed that these two policy documents did not support agriculture in modern Mali's landscape. This resulted in the under-utilization of digital tools by agricultural extension officers, reducing the dissemination of agricultural information for higher yield towards farmers in the country. This study recommends the recasting of both documents in response to the study findings.

Pour exploiter le potentiel des technologies de l'information et de la communication (TIC), les pays en développement doivent élaborer des politiques nationales des TIC qui servent de cadre à l'intégration de ces TIC dans toutes les sphères de la société. En l'absence de telles politiques, il y a souvent un manque de coordination des interventions fondées sur les TIC, ce qui conduit souvent à un (possible) gaspillage de ressources. Par conséquent, Il est toujours nécessaire de définir un cadre national pour la promotion et l'application des TIC dans divers secteurs de l'économie d'un pays. Le but de cette étude était d'analyser la politique nationale des TIC dans le domaine de l'agriculture au Mali. L'étude a adopté la théorie de la connaissance comme cadre théorique. De plus, cette étude a adopté une méthode de recherche qualitative, les données étant collectées à l'aide de documents de politique et d'entretiens semi-structurés. Les données ont été analysées en utilisant la méthode d'analyse qualitative du contenu (QCA) à l'aide du logiciel NVIVO version 12. Les résultats ont montré que le Mali disposait de deux documents de politique qui articulaient la stratégie du pays pour l'utilisation des TIC dans le secteur agricole. Ces documents étaient la loi d'orientation agricole et la stratégie nationale pour le développement de l'économie numérique. Un examen plus approfondi a révélé que ces deux documents ne correspondaient plus au paysage agricole du Mali. Cela a entraîné une sous-utilisation des TICs par les agents de vulgarisation agricole, réduisant l'accès des paysans à une vulgarisation agricole pour un meilleur rendement dans le pays. Cette étude recommande la refonte des deux documents en réponse aux résultats de l'étude

Keywords: ICT policy; Agricultural productivity; Extension services; Developing countries; Mali

Mots clés: politique des TIC; Productivité agricole; Services de vulgarisation; Pays en voie de développement; Mali

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Introduction

Information and communication technology (ICT) policy is a dominant feature in the improvement of agricultural productivity in developing countries. ICT-driven agricultural information is one of the ways to realize higher yields (Kante, Oboko, & Chepken, 2019). Furthermore, it has been argued that ICT policies can help increase agricultural production (Chavula, 2014; Kunyenje, 2019) in developing countries. As agriculture constitutes the backbone of the economies of many developing countries (Aker et al., 2016; Kante, Oboko, et al., 2017; Msoffe & Ngulube, 2016), it is imperative to adopt and implement national ICT policies to enhance agricultural productivity. In the absence of appropriate policies, different stakeholders often engage in diverse actions for the same beneficiaries to achieve the same objectives which leads to a waste of resources (AU, 2008).

Many developing countries have developed or are in the process of developing ICT policies. Kunyenje (2019) argues that about 84% of African countries have adopted national ICT policies. Some developing countries have put in place ICT policies aligned with their development objectives (Diga et al., 2013) in agriculture (Kunyenje, 2019) and e-government (Sullivan & Clarke, 2010). For instance, Nigeria (Yusuf, 2005), Kenya and Rwanda (Waema et al., 2005), Uganda (Waema et al., 2005) and Senegal (Sagna, 2018) have all implemented national ICT policies in the agricultural sector.

Despite the adoption of ICT policies by many developing countries in Africa, the improvement of agricultural productivity remains an issue. For instance, Kante et al. (2019) argue that Mali's agricultural practices yield low productivity. A similar observation has been made regarding the agricultural sectors in Ethiopia (Berhane et al., 2018), Senegal (Seck, 2017), Kenya (Warinda et al., 2020), Uganda (Warinda et al., 2020) and Rwanda (Warinda et al., 2020). Hence, one may assume that ICT policies in those countries have not yet led to an increase in agricultural production.

The low agricultural productivity of these countries has been linked to policy-related issues, amongst other factors. For instance, the Food and Agricultural Organisation (FAO, 2017) reports that Mali's policies present inconsistencies between the overall policy objectives, measures adopted to pursue these objectives and the effects they generate. Additionally, Makoza (2017) reports that the intended policy outcomes have not been adequately realised in Southern Africa. Furthermore, it has been reported that the main constraint in the agricultural sector is the lack of innovative technologies such as information technology (IT) for development. Information technology (IT), or information and communication technology (ICT), plays a vital role in advancing economic growth and reducing poverty (Hlungulu et al., 2010; Minges, 2006; Ordóñez, 2015; Türen, Gökmen, & Keser, 2016). Therefore, there is a need to assess these ICT policies regarding agriculture and to suggest ways in which they could be enhanced to assist in increasing agricultural productivity.

There is a growing body of knowledge that portrays the nexus between ICT policy and development in developing countries. For instance, Kunyenje (2019) uses the case of Malawi to investigate the influence of external actors on national information and communication technology policy formulation in developing countries. Ordóñez (2015) has studied the impact of the information society in the global South and has highlighted

the link between ICT policy and development. Furthermore, Diga et al. (2013) have explored the link between ICT policy and poverty reduction in Africa.

Nevertheless, a much-debated question is whether these ICT policies in the field of agriculture have been implemented and the results thereof. Although a country may have an ICT policy, this does not imply its implementation (Collin & Mmapeteke, 2018). For instance, Kunyenje and Chigona (2019) report that although Malawi has adopted a national ICT policy, its implementation remains an issue. The ICT policy for agriculture in Mali has been reported as inconsistent (FAO, 2017). Additionally, Collin & Mmapeteke (2018) argue that in East Africa none of the Southern African Development Community (SADEC) countries have implemented the ICT policies that they have adopted. It has been noted that the implementation and adequacy of these ICT policies remain under-researched issues thus far. Furthermore, while ICT policies for development research is a growing field (Kante, 2020), publications regarding ICT policies for agriculture in developing countries remain sparse. Thus, there is a need to further investigate the implementation and adequacy of national ICT policies in the agricultural sector of developing countries.

It was in this context that this study explored the adoption and implementation of ICT policies in agriculture in developing countries, using Mali as a case study. The specific research questions guiding the study were:

- a) To what extent does the national ICT policy of Mali support agriculture?
- b) To what extent are ICTs used in the agricultural sector of Mali?

Yusuf (2005), quoting Hafkin (2002), argues that ICT policies can be categorized as vertical, infrastructural, and horizontal policies. Vertical ICT policies address sectoral needs such as education, health, agriculture, and tourism. An infrastructural ICT policy, on the other hand, deals with the development of national infrastructure such as telecommunication infrastructure. A horizontal ICT policy deals with the impact of ICT on broader aspects of society such as freedom of information sharing, tariffs, and pricing, privacy, and security. A national ICT policy is a formal specification of the “objectives, goals, principles and strategies” that are “intended to direct and control” the implementation and application of ICTs (Kunyenje, 2019:151).

This study considered the mobile phone as the *ICT* means used to deliver extension services to the farmer as the literature (Aker et al., 2016; Barakabitze et al., 2017; Bertolini, 2004) reports that it is one of the best ways to disseminate agricultural information to farmers in Africa. Furthermore, The paper begins by reviewing the context of Mali’s ICT policy concerning agriculture. followed by a description of the theoretical framework underpinning the study. This is followed by the literature review and methodology sections. The results and discussion section presents the findings and discusses them considering the literature. Finally, the study’s conclusion recalls the objectives and what was achieved as well as recommendations for further investigation. The conclusion also highlights the study’s limitations.

Literature Review

Mali has experienced a slowdown in economic development since 2015, with a real gross domestic product (GDP) increase of 5.2 per cent (compared with 5.8 per cent in 2014) due to the poor performance of the agricultural sector with a growth rate of only 3.9 per cent, down from 14.8 per cent in 2014 (FAO, 2017). Agriculture accounts for more than 35 per cent of GDP and 80 per cent of overall Malians' livelihoods. The literacy rate is approximately 33.1% for adults (15 years and above). However, in rural areas, this rate is about 24.4% (INSTAT, 2015). Mali's agriculture is dominated by small-scale farmers (68%) who contribute 37% to the country's GDP (FAO, 2013). Cereals constitute the main part of the agricultural production of the country (Aparisi & Balie, 2013). The low agricultural production in Mali has led to a low food security level. Mali's Institut National de la Statistique (2019) reports that about 33 per cent of households in rural areas in Mali have difficulty in providing enough food for themselves. Thus, there is a need to improve the country's agricultural productivity.

However, Mali has established some policies to improve its agricultural productivity. Mali's main objectives of fostering socio-economic development and improving food security are expressed in four main documents: the Growth and Poverty Reduction Strategic Framework 2012–2017 (CSCRFP), the Agricultural Orientation Law (LOA), the National Food Security Strategy (SNSA) and the Strategic Framework for Economic Recovery and Sustainable Development in Mali 2016–2018 (CREDD) (FAO, 2017). The trend of these policies for the agricultural sector has focussed on increasing domestic rice production, reforming the cotton sector, maintaining input subsidy programs, and improving access to land.

Nevertheless, there are still some challenges in Mali's agricultural sector. For instance, the Food and Agricultural Organisation (FAO, 2017) reports that Mali's (ICT) policies present inconsistencies among overall policy objectives, measures adopted to pursue these objectives and the effects they generate. A literature review has revealed that only a few studies have been undertaken on the issue of an ICT policy in the field of agriculture in Malawi (Kunyenje, 2019), Kenya (Waema et al., 2005), Tanzania (Bwalya & Silumbe, 2007) and Senegal (Sagna, 2018). At the time when this study was conducted, there was no data available on an ICT policy on agriculture in Mali. Hence, there is a need to investigate whether Mali's ICT supports the agricultural sector and the extent to which it does so.

Theoretical Background

This study has used the Theory of Knowledge of Foucault (1977). The theory draws a close link between knowledge and power. Foucault (1977) maintains that human experience is based on communication, with structures arising from the rules of communication. Furthermore, knowledge gives way to power that generates further knowledge. It is often assumed that whoever has knowledge or information is empowered and whoever lacks it, is incapacitated. In the case of an ICT policy in agriculture, the concept of *information* is translated as the implementation of an ICT policy (through the dissemination of agricultural information through ICT) and *power* could be labelled as the farmers gaining knowledge on how to increase their productivity (through ICT means). The literature (Msoffe & Ngulube, 2016) suggests that well-informed farmers

make wiser decisions which, in turn, results in an increase in agricultural yields (Kante et al., 2019) and hence, more agricultural productivity (Barakabitze, Fue, & Sanga, 2017; Kante et al., 2017; Siyao, 2012).

However, for farmers to be empowered, the extension officers themselves need to be firstly empowered. The extension officers could be empowered by making ICT tools such as cell phones available to them and by training them on their use. In the context of the theory of knowledge, an *ICT that supports agriculture* (RQ1) is related to the knowledge construct of the theory while the *extent to which ICTs are used in the agricultural sector of Mali* (by extension officers) (RQ2) is related to the power construct of the theory. The conceptual framework is hence displayed in Figure 1 below.

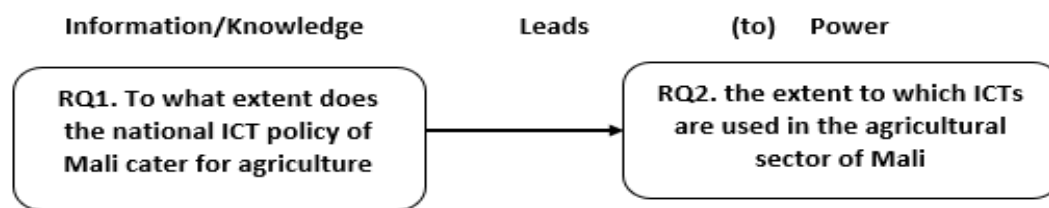


Figure 1. Conceptual Framework

Material and Methods

This study was conducted using qualitative methods. Qualitative research methods are used in the social sciences and particular management studies and applied social policy research (Srivastava & Thomson, 2009).

Data Collection

Policy documents (qualitative data) were collected and analysed. As the introduction of ICT in Mali was traced back to the 1990s (Kante et al., 2017), we collected policy documents that covered the period from 1991 to 2018. An online search was carried out in four academic databases (Google Scholar, ResearchGate, Scopus, and Web of Science) and on the websites of Mali’s regulatory services from August 2018 to May 2019. We were able to access 17 documents that reported on the laws, ordinances, and reports on ICTs. An initial screening of the search results led to a selection of 10 documents to be analysed (after removing duplicates). In addition to the policy documents, we interviewed ten (10) stakeholders in the field of ICT and agriculture (policy-makers, agricultural extension officers and researchers). The sample size of 10 interviewees was acknowledged as adequate in previous qualitative studies (Guest et al., 2006). The 10 stakeholders (one policy-maker, two ICT4D researchers, three ICT practitioners and four public extension officers) were from the *Autorité Malienne de Régulation des Télécommunications, des Technologies de l’Information et de la Communication et des Postes* (Mali’s Regulatory Authority for Telecommunication, Information and Communication Technologies and Postal Services [AMRTP]); *Agence des Technologies*

de l'Information et de la Communication (the Information and Communication Technologies Agency [AGETIC]) and the *Direction Nationale de l'Agriculture* (National Directory of Agriculture [DNA]). The choice of these three institutions was informed by the fact that:

- a) The AMRTP is the ICT regulatory authority in Mali; therefore, it is supposed to be aware of any public policy on ICTs, including any policy that applies to the agricultural sector
- b) The AGETIC is the implementing agency of ICT services of the state and implements all public policies in the field of ICT
- c) The DNA is also Mali's public extension service; hence, it was deduced that the DNA should be aware of any existing public ICT policy in agriculture and the current state of its application.

Data collected from these stakeholders was used to complement the policy documents to answer the research questions.

Data Analysis

The content analysis technique has been used to analyse the data coupled with a deductive approach. This technique has been widely applied in similar settings and recommended by various scholars (Gomez, 2013; Hsieh & Shannon, 2005; Kohlbacher, 2006; Siyao, 2012). Content analysis is a research method used for replicating and validating inferences from data to their contexts to provide knowledge, new insights, a representation of facts and a practical guide to action (Elo & Kyngäs, 2007). Deductive content analysis is often used in cases where the researcher aims to retest existing data in a new context (Catanzaro, 1988). This may also involve testing categories, concepts, models or hypotheses (Elo & Kyngäs, 2007).

For the collected documents, the analysis process entailed checking whether one of the following terms was present in each of the 10 documents that were selected from the initial search: Information and Communications Technology/Technologies, ICT, agriculture, agricultural, e-agriculture or agricultural extension. These terms constituted the first inclusion criterion for the study. Only five documents met the inclusion criterion. Since the study was only concerned with public policies on ICT and agriculture, we applied another round of screening by searching for the words *information and communication technology/technologies* and *agriculture/agricultural* in the five documents. Two of the five documents were then selected: the *Loi d'Orientation Agricole* (LOI) (Law of Agricultural Orientation) and the *Stratégie Nationale de Développement de l'Economie Numérique* (National Strategy of Development of the Digital Economy) (Digital Mali, 2015-2020). The final analysis then focused on these two documents.

The interviews were transcribed and coded using the Nvivo version 12 software. The first step of the analysis was to assign codes to the data (data from interviews and documents). Secondly, we grouped these codes into categories. Thirdly and finally, these categories were grouped to form the themes based on the research questions. These research questions were mapped to the constructs of the theory of knowledge as shown in Table 1. The knowledge and power constructs were respectively operationalized as the RQ1 and RQ2.

The codes, categories and themes used to answer the research questions are presented in Table 1. The first theme of agricultural policy is found in the *Loi d’Orientation Agricole* (LOA) document.

Table 1. Coding schemes

Codes	Categories	Themes	Research Question	Theory of Knowledge’s Constructs
Gender in agriculture	Gender_in_agriculture	Agricultural policy	To what extent does the national ICT policy of Mali support agriculture	Knowledge
Lack participatory approach	Lack participatory approach			
Farmers	Agricultural stakeholders			
NGO				
State department				
Productivity	Productivity	Productivity	To what extent are ICTs used in the agricultural sector of Mali	Power
Public policy	Public policy	Public policy		
Horizontal policy	Horizontal policy			
ICT	ICT			
ICT4D				
ICT4AgTool				
Encounter ict tool				
Vertical policy		Vertical policy		
ICT4Ag policy				
Lack participatory approach				
No ICT4Ag policy				
Recommendation actions to be done	Recommendations			

Furthermore, we looked at the nodes (codes) derived from the two documents. This revealed that the terms used in the documents were not linked to any action or objectives that could help to achieve the intended goals. Only one node reported that “(the State should) increase the use of digital technology in all sectors of the national economy ... (to) identify priority project leaders to implement with an appropriate business model in the areas of e-Learning, e-Health, e-Commerce, e-Tourism, e-Agriculture, e-Culture, e-Transport, etc.”. That node was not mentioned anywhere else neither in the *Plan Mali Numerique 2020* nor the LOA document. Ironically, the LOA specified in Title I, article 2:

The Agricultural Orientation Law covers all the economic activities of the agricultural and peri-agricultural sector including agriculture, livestock farming, fishing, and fish farming, aquaculture, bee-keeping, hunting, forestry, gathering, processing, transport, trade, distribution, and other agricultural services, as well as their social and environmental functions.

Can one achieve what is proposed in the LOA without ICT? The answer is “no”, according to recent literature (Isaya, Agunga, & Sanga, 2018; Lwoga, Ngulube, & Stilwell, 2010; Kante et al., 2019). Furthermore, Kante & Ndayizigamiye (2020) argue that an (ICT) policy comprises the content, context, actors and process that are interrelated. In the case of Mali, that has not been the case, as the content (objectives) and the actors (extension services through the LOA) of the ICT policy are not related. Hence, we can conclude by arguing that the ICT policy barely addresses the agricultural sector in Mali.

This conclusion is corroborated by findings from the interviews. For instance, one interviewee, when asked if the ICT policy dealt adequately with the agricultural sector in Mali, said, “. . . *Not at all . . .*” On the same question, another said that “*I do not think that the State has nothing to do with the use of ICT in extension services . . . It is our personnel initiatives . . . In Koulikoro, we have only 175 extension officers to serve more than 1,000 villages. Could you imagine that ratio farmer to extension officer? Has the State given us any mobile phone? No!!!! The state cannot hire more extension officers . . . the least that they can do is to provide us with mobile phones, airtime so that we can reach more farmers.*” Other responses included “*I cannot tell*”, “*I do not know*”, “. . . *maybe but not sure . . .*”, “. . . *I have not seen any document regarding ICT policy in agriculture*”, “*I do not think so . . . we have elaborated the Agricultural Orientation Law, the content of which we do not know. There has not been sufficient upstream work on this document . . . and it does not consider ICT.*” We can, therefore, argue that the ICT policy does not adequately deal with agriculture in Mali.

A note of caution is drawn here since we were looking at the policy from the view of extension officers (practitioners). A contrasting point on the same question came from one interviewee (an ICT practitioner): “. . . *we (AGETIC) are working with UN Women on the project - buy from women mali.buy-from-women.org . . . that means that the State through us (AGETIC) is doing something towards ICT application in Agriculture.*” For this interviewee, the state is “*doing something about ICT in Agriculture*”. One could now ask if this was the result of a policy or not. Our dataset did not reveal any results suggesting that the “. . . *doing something about ICT in Agriculture*” is the result of a policy.

To what extent are ICTs used in the agricultural sector of Mali (Research question 2)?

Research question 2 was answered using data from the interviews and the policy documents. More than 80 per cent of those interviewed reported that ICTs played a role in Mali's agricultural sector. When asked whether they had met or worked with an ICT based agricultural extension service, about 50 per cent responded positively with a "yes" answer. However, naming these ICTs was problematic for most of them. Only the *ICT practitioners* from AGETIC and two other *extension officers* could report the name of ICT-based extension service.

The reported ICT-based extension services were Myagro (N'gasene), Senekela from Orange Mali, BuyfromWomen and Mali agro météo. Myagro is a private extension service that helps farmers obtain information that can help increase their crop yields such as using modern planting techniques. It uses the platform (ICT tool for extension services) *N'gasene*. The service further provides access to simple agricultural machinery that can make agricultural work more efficient and effective, and eventually helps farmers generate more profits from their produce (Kante et al., 2019). Senekela is an ICT value-added service (VAS) launched by Orange Mali (network provider) in 2014 in the region of Sikasso. It has set up a call centre with agronomists who advise farmers in French and in *Bambara* (a local language) on issues related to farm inputs such as planting methods, the use of seeds and fertilisers, sowing times, market prices and other agricultural issues (Kante et al., 2017). UN Women is piloting BuyfromWomen, a data-driven enterprise platform that combines an open-source end-to-end, cloud-based and mobile-enabled supply chain system to connect women farmers to information, finance and markets (Unwomen, 2017). This product innovation enables women farmers to have a better understanding of their business lifecycle. It provides real-time reports in dashboard form of key performance indicators, including forecast yields and sales revenue (Unwomen, 2017). The only public tool reported is *Mali agro météo*, which is deployed at the weather agency (*Mali météo*).

Three main points can be derived here:

- a) Public agricultural extension agents (often) use ICT tools in their work.
- b) These tools are not made available to them by their services (or department).
- c) The private sector might be working with these public agricultural extension services.

The pending question is whether the use of ICT tools is driven by the state policy or whether it is isolated actions of these public extension officers. To that observation, the respondents (the extension officers) reported that "[o]ur (extension) department does not have an ICT based extension service, I only saw it when the private services came to present theirs" (i.e. the ICT tool *Senekela* or *N'gasene*).

An apparent interesting point is that some respondents reported that the ICT policy in agriculture had been implemented. For instance, a respondent, when asked if the state had implemented the ICT policy in agriculture, reported, ". . .of course, through the AGETIC, which is a state-owned technological agency attached to the Ministry of Digital Economy and Foresight". However, the data from the interviews showed that AGETIC was

working with the UN Women on ICT-based agricultural information dissemination called “BuyfromWomen”. This application (app) was neither known to the extension services department nor to the policymakers whom we interviewed. This meant that it was out of the reach of the extension services. The explanation could be that the external actor (UN Women) was playing a key role in the implementation of the policy but that AGETIC, Mali’s department that was supposed to disseminate the policy to the other departments (extension services), had not yet done so. This explanation was supported by the policy process theory of Makoza and Chigona (2013). The theory stipulated that the policy implementation was done through activities of the executive departments of the state. These departments in our case included AGETIC and the DNA (extension services). Since the respondents did not report any activity of the DNA related to an ICT policy in agriculture, we could say that the implementation of the policy remained an issue.

Based on the above results and observations, it is difficult to ascertain that the current ICT policy caters for agriculture in Mali. It is true that the analysis of the document *Mali Numerique 2020* indicates the adoption of ICT in agriculture (electronic agriculture and agriculture based on information and communication technologies). However, this document is barely linked to the LOA. It is based on the analysis of the LOA document which clearly reveals that the words/terms *TIC, e-agriculture, Technologies de l’Information et de la Communication* are missing from that document. The LOA aims to promote a sustainable, modern and competitive agriculture relying first and foremost on recognized and secure agricultural family farms by maximizing the country’s agro-ecological potential and agricultural know-how, and the creation of an environment conducive to the development of a structured agricultural sector (*loi d’orientation agricole*, 2006). Can the LOA policy achieve it without ICTs? This is not possible, according to many studies (Aker et al., 2016; Kunyenje & Chigona, 2019; Kante et al., 2019). Several other studies in Mali (De la Rive Box et al., 2015; Kante et al., 2019; Palmer, 2011; Palmer, 2015), Tanzania (Barakabitze et al., 2017; Isaya et al., 2018), Kenya (Wyche & Steinfield, 2015) and China (Amin & Li, 2014; Zhang et al., 2016) have also pinpointed that this cannot be achieved without the use of ICTs.

However, almost all respondents reported a similar recommendation which was “*The state (of Mali) must integrate ICT in the agricultural production process*”. A public agricultural extension officer reported that this could be done by “*training extension agents on ICTs*” while another respondent indicated that this could be achieved by reporting “*(and) provid[ing] an ICT-based agricultural extension service for the DNA and its departments everywhere in the country*”. Furthermore, there was a lack of vertical policy in the field of ICT for agriculture (and perhaps in many other fields) in Mali. The AMRTP did not have any framework on ICT implementation in the agricultural sector. This corroborated the findings of Yusuf (2005), who indicated 15 years ago that the vertical policy had been neglected. It also pointed to the poor state of vertical ICT policy research in Mali and elsewhere, as reported by Gillwald (2010) and Heeks (2007).

Implications of the implementation of an ICT policy in agriculture in Mali

The agricultural sector accounts for more than 35 per cent of the GDP of Mali (FAO, 2017). It is dominated by small-scale farmers (68%) (Aparisi & Balie, 2013). The agricultural sector in Mali is characterised by low productivity (Kante et al., 2019) due to many factors such as drought, lack of extension services (with a ratio of 11,891 farmers for one extension officer), amongst many others. This has resulted in lower food security

levels in Mali where 37.7 per cent of households have difficulty nourishing themselves (INSTAT, 2014). Food insecurity is, therefore, a concern for farmers, researchers, the practitioner (extension officers), policymakers and the general population.

One way to address the issue of low productivity in the agriculture sector is through the use of information and communication technologies (ICTs) (Isaya et al., 2018; Kante et al., 2019) to disseminate extension services to farmers. In the context of this study, agricultural information (the knowledge construct of the theory of knowledge) acquired through ICT may empower (power construct of the theory of knowledge) extension officers to guide farmers in their quest to increase productivity. In this case, farmers will gain basic knowledge to increase their agricultural productivity (Msoffe & Ngulube, 2017). However, to achieve this, there should be a policy that guides extension officers on *how to* disseminate extension services using ICT. The use of ICT will empower them to reach more farmers (Aker et al., 2016; Sylla et al., 2019). without appropriate policies, the use of ICT by (public) extension services will remain problematic. In other words, without an adequate implementation of an ICT policy in agriculture (by extension services) the outcome (productivity) will remain problematic. That is why many of the respondents of this study reported as a recommendation that *“It (the State) must integrate ICT into the agricultural production process” / “I think that the state must be able to put valid conditions to make a political policy (on ICT in agriculture)” / “Given the importance of ICTs in development in general and the agricultural sector in particular, the State must invest in supporting the capacities of the structures (public extension services) in this area to ensure the growth of the country.”*

In conclusion, low productivity can be linked to the state not having developed a clear and comprehensible ICT policy. This confirms the report from the FAO (2017), stating that Mali’s policies present inconsistencies within overall policy objectives, measures adopted to pursue these objectives and the effects they generate. Therefore, concerning the Theory of Knowledge, without information (without a policy that guides how ICT should be applied in agriculture) at the disposal of extension officers, these officers continue to lack the knowledge that forms the basis for extending their services to empower farmers.

Conclusion

This study set to analyse the implementation of the national ICT policy in agriculture in Mali using the Theory of Knowledge as the theoretical lens. Specifically, the study responded to two research questions:

- a) To what extent does the national ICT policy of Mali support agriculture?
- b) To what extent are ICTs used in the agricultural sector?

Findings from this study revealed that current Mali’s ICT policy does not adequately deal with agriculture. Regarding the second research question, we pointed out that the extension officers were not empowered (enough) by the ICT policy to use ICT-based extension services for agricultural information dissemination towards farmers as suggested by the Theory of Knowledge. So far, the current ICT policy has not translated into an increase in agricultural productivity in Mali. It will then be of interest for Mali to have a policy that provides guidelines on how to use ICT in agriculture to increase agricultural production and food security.

This study did not investigate the opinions of farmers regarding the implementation and use of ICT in agriculture, which is a limitation. Therefore, it is recommended that a follow-up study involving farmers (as participants) be undertaken. Furthermore, a quantitative study could be devised to investigate the factors (and their interactions) that lead to the current status quo (about ICT use in agriculture) and what could be done in future to improve the policy-making environment so that ICT integration in agriculture and other cross-cutting issues are addressed.

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