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ICTs in Linking Farmers to Markets: Innovative Mobile Applications and Lessons Learned from the Past and the Future

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The Technical Centre for Agricultural and Rural Cooperation (CTA) is a joint international institution of the African, Caribbean and Pacific (ACP) Group of States and the European Union (EU). Its mission is to advance food and nutritional security, increase prosperity and encourage sound natural resource management in ACP countries. It provides access to information and knowledge, facilitates policy dialogue and strengthens the capacity of agricultural and rural development institutions and communities.

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Executive summary

Mobile phones are more than tools for communicating; farmers consider them as a status symbol in society. Mobile money provides complementary services to farmers in the areas of banking, insurance and microfinance.

Farmers need mobile applications that can meet their changing information needs and suit their information seeking behaviour.

Unbanked people can be reached by different mobile money applications. This will complement the effort of governments to reach the rural poor and improve access to bank accounts. Currently more people have mobile phones than bank accounts.

Africa constitutes 14% of the world population; knowledge generated and mobile applications developed in Africa should be shared from South to North, by making visible African technologies and knowledge worldwide e.g., M-PESA.

There are different types of partnerships for developing mobile applications in agriculture, particularly to link farmers with markets: public–public, public–private, private–private. Partnerships are formed among non-governmental organisations (NGOs) and public and/or private sectors. Partnership is also needed, for instance in the case of countries like Ethiopia, within and between universities in the areas of agriculture, information science and computer science. In such condition, many innovative mobile applications can be developed which can transform the lives of smallholder farmers.

In order to link farmers with markets, good physical infrastructure (i.e., roads and electricity) is not enough. Equally, information infrastructure (mobile network access) is needed. The human network (human communications) lubricates the relationship between and among various actors in the value chain.

Many refined insightful observations and lessons learned are mentioned in this document.

Introduction

Globally, agriculture takes centre stage as the engine that can transform nations' economies. Similarly, the place and role of smallholder farmers from local to global levels are recognised by the respective governments and international partners as a way to avoid age-old problems like hunger, miserable lives, etc. Currently, it is believed that smallholder farmers can feed the world's undernourished people. It has significant contributions both at the micro and macro levels.

Small-scale agriculture is a must, not an option, for developing countries like Ethiopia. So, the issue changed from why to how to empower smallholder farmers. In order for this to happen, just providing inputs (improved seed and fertiliser) is not enough; they should be supported by different ICTs, e.g., mobile phones. Subscription to and accessibility to mobile phones is not enough in itself; this paper discusses mobile applications in agriculture, specifically those applications targeted to link smallholder farmers to markets. Here we will raise and discuss different relevant issues, present insightful observations and lessons learned from mobile applications in agriculture, draw conclusions, suggest solutions and the way forward and finally propose some topics for further research and as points for further discussions.

Scope

As much as possible, efforts have been made to discuss mobile applications that focus on different agricultural practices, but more focus is given to those mobile applications developed by and for the context of developing countries, particularly ACP countries. A list of mobile applications specifically designed to link formers to the markets; and those applications that enhance communication and market transparency between and among actors in the value chain are also discussed. Lessons learned are documented.

Purpose

The purpose of the overview is not just to mention a list of mobile applications developed for agriculture. Its innate purpose is to learn from success and failure factors. This paper suggests ways that youth can be persuaded to get involved in agriculture. The smallholder farmers' information needs, preferences and information seeking behaviours will be reviewed so as to design appropriate mobile applications that link them better to markets at different levels. Then we examine the marriage of ICTs and smallholder farmers mainly in the context of ACP countries.

Genesis of agriculture

It is believed that farming has been around in different corners of the world roughly from 10,000 to 12,000 years ago. An orthodox view of agriculture is that it is merely about farming and livestock rearing and is considered to be labour intensive. Agriculture is in fact a knowledge intensive sector whose return on investment is relatively high. It is more than just farming and livestock rearing. It is a business. It requires passion beyond scientific knowledge. Agriculture is not a single sector, as it relates to health, natural resources management and rights, to mention just a few. Agriculture is a tradition and cultural heritage

that needs to be preserved for succeeding generations. Currently nations can preserve their agricultural heritage with appropriate ICT applications (websites, different internet and mobile applications, etc.). Preservation is the last segment in the agricultural information life cycle.

Smallholder farmers and mobile phones

Agriculture is the engine for Eastern Africa's economy. Smallholder farmers are dominant in developing countries. In Asia and sub-Saharan Africa, they produce about 80% of the food consumed (IFAD, 2011). They are the hope for the future to reduce undernourishment. A third of the global people are fed by an estimated 500 million who have just less than 2 ha of land (Oxfam, 2011). Mobile communications can help to meet the challenge of feeding an estimated 9.2 billion people by 2050 (Accenture and Vodafone, 2011:7). Smallholder farmers are tacitly participating in different markets, since what is collected from them locally is being sent to different foreign markets. In one way or the other, smallholder farmers are playing a central role in the current rise of Africa. Similarly, the stimulating African economy will also impact them positively. However, small-scale farmers have poor market infrastructure, inadequate marketing experience and agricultural inputs (Munyua, 2007).

Globally, mobile subscribers were 3.2 billion in 2013 and will reach 3.9 billion in 2017 (GSMA, 2013). Surprisingly, four out of five new mobile connections are taking place in developing countries.

Mobile telecommunications can connect farmers to markets, finance and education, making it possible to monitor resources and track products. This unlocks productivity potential while helping to manage the impacts of increased production (Accenture and Vodafone, 2011:8). ICTs (mobile) enable smallholder farmers to reduce uncertainty and thereby meet their information needs. It also empowers them to make wise and informed decision on price, to whom to sell, what to produce next time, whether to diversify their produce or not etc. Access to market data is extremely important to people in the agricultural sector, as prices for their products can change on a daily or even hourly basis (Woodill and Udell, 2012:63). We should remember that the developing world is "more mobile" than the developed world (World Bank, 2012:3)

Agricultural market information: From horses to post and to mobile

In the last number of decades, different formats and channels (containers of information) were used to provide market and price information, particularly for rural smallholder farmers.

According to a key informant, in West Hararege, Ethiopia in the 1950s, agricultural market and price information about different commodities was provided from person to person, with people travelling from one place to another on horseback. After that the same information was provided through post offices. Currently, globally market, price and mobile commodity exchanges offices provide other market-related information. This is the case in many African States as well.

Particularly, the new knowledge ecology allows farmers and other actors not only to be beneficiaries but creators of information and knowledge.

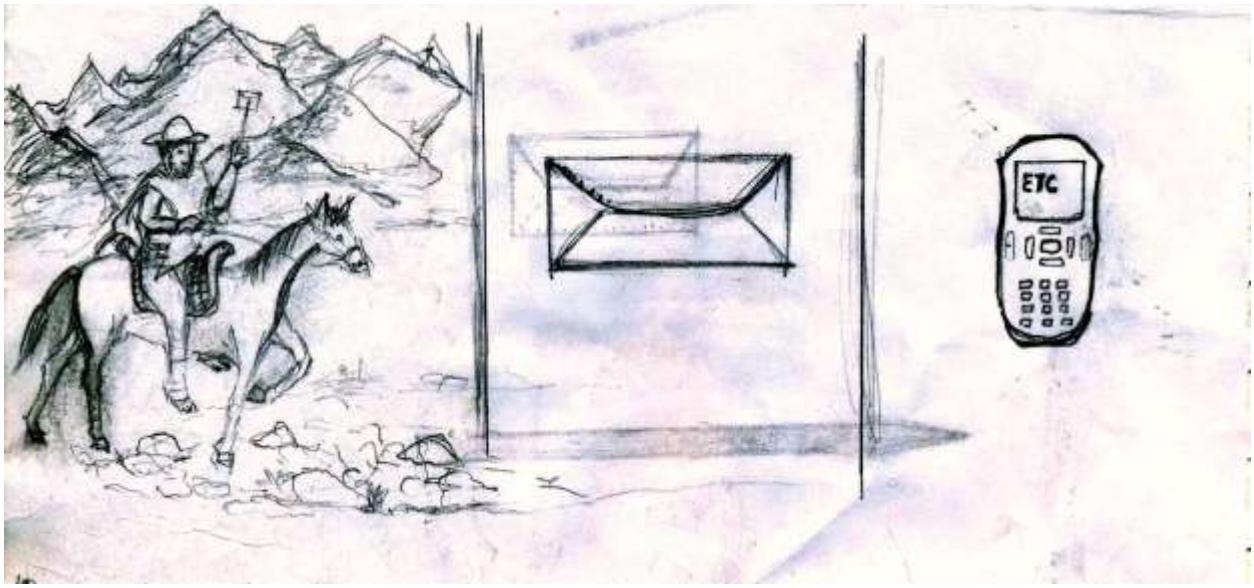

Plate 1. Different information formats and channel of information.

Illustration by Samson Mammo, 2013

Mobile and agricultural marketing value chain

Farmers need technical as well as market information. Mwakaje (2010) revealed that out of the surveyed 200 farmers, 23% of them replied that they are using ICTs to find market information.

ICTs, particularly mobile phones enable farmers to be on an equal footing with other actors. It facilitates power shifting or a change in the power balance between smallholder farmers and brokers and other actors in the value chains. ICTs are democratising our communications; particularly appropriate mobile applications enhance market transparency and help to give a better return for farmers' produce. It enhances the visibility of farmers in the value chain and enables actors to play multiple roles in the value chains. After all, it adds value to farmers' efforts and returns.

Mobile phones serve all of the actors in the value chain. ICTs (mobile applications) are changing the way actors are communicating with each other. They can facilitate both vertical and horizontal communication both within and among institutions and actors. To put it in a nutshell, mobile applications promote an inclusive value chain.

Issues

From mobile accessibility to mobile applications

People often joke about the use of applications on mobile phone; they say, "Are you mobile carrier or mobile user (of different applications)?" which means that you just own it but did not use it for any purpose or applications (or even did not call anybody). The farmers know well that 'the use of mobile is more than just talking on it.' We should listen to the farmers and design appropriate mobile applications that really solve their different agricultural problems, particularly marketing and price issues. It is obvious that ICTs are the future of extension. Put differently, the time has come to move from accessibility of mobile-to-mobile

applications. This is the time to move from discussing simple mobile distribution, affordability and accessibility to different mobile applications. Actually, agriculture does not lack resources; it lacks policy and ICT application.

Box 1. Locally assembled mobiles overcome infrastructure and network problems

In Ethiopia, G-Tide mobile is being assembled which has a light and enables users to use internet, radio and television together. Appropriate mobile technologies are being assembled even in-country, which are suitable for different mobile applications and which practically overcome our existing infrastructure and network problems. They also merge old ICTs (radio and television) with modern ICTs (internet), so agricultural information providers can reach farmers in any of these communication channels and medium types.

ICTs are not an end in themselves, they are a means to an end

ICTs are expressed as enablers, empowering tools, facilitators, catalysts and the like. ICTs are not a distinct sector, so they need to be streamlined. ICTs cannot be seen outside this context and understanding. ICTs are not panacea, but when we converge them with other ICTs, it adds value in the area that we apply it in.

In other words, access to ICTs means access to networks. Similarly, access to networks (markets) is a means to an end, not an end in itself. In the same vein, open source software is not an end in itself; it is merely a means to an end (to develop different mobile applications). After all, at the end of any mobile applications, smallholder farmers are not concerned about the software/coding language that was used for the app as long as it works well. ICT is a tool, not an end in itself.

Information need, preferences and information seeking behaviour of smallholder farmers

In order to understand how mobile agriculture should work, it is necessary to analyse the information needs of farmers and distributors of agricultural products (Woodill and Udell, 2012:5). India's agriculture has now entered a post-Green Revolution stage. Demands for agriculture technology are changing and diversifying. Demands for agricultural information are changing every year. In recent decades, farmers were asking more technical information, but now their needs have shifted to market prices and information that adds value to their efforts. The main objective of farmers has shifted from high production to higher and better returns.

The information needs of farmers have a commonality no matter where in the world they are located (Woodill and Udell, 2012:6). Their information needs fluctuate according to the agricultural calendar. Understanding users' information need, preferences and information seeking behaviour and grasping the ultimate vision of the government in that specific country is central to providing an effective information service via mobile applications. We need to spend 90% of our time on solutions, not just on talking about problems.

Mobile phone as a complement or substitution to the traditional marketing and price information

In our existing situation in many African countries, it would be difficult to move to electronic platforms; it would be more effective if we complemented the new and modern ICTs with traditional ICTs wisely. In other words, it is recommended that ICTs are used as a complement rather than as a substitution now. However, in the long run, it is advisable to fully substitute traditional ways of doing things with ICTs.

Information poverty is the root cause for all other types of poverty

Globally, access to ICTs and mobile phones are not considered as a prime need among many researchers and international partners. According to the United Nations currently, there are more people across the globe that have better access to mobile phones than to toilets and clean water. Surprisingly, currently rural people are more interested in getting a better mobile phone network coverage than meeting all of their basic needs. This implies that information poverty is the root cause of all other types of poverty. Similarly, international partners and governments of different countries should engage in a kind of paradigm shift from providing merely food aid to provision of ICTs and knowledge. Currently knowledge is viewed as a fourth national resource, just like land, labour and capital.

Linking farmers to local and international markets

Why should farmers be linked to markets? Even if we provide improve seeds and fertilisers to farmers and improve productivity, we cannot transform smallholder farmers unless we secure markets for them. So, linking farmers to markets is not a luxury, it is a must.

Convergence of mobile, internet and radio

Blending of old ICTs (radio and TV) with modern ICTs (mobile applications) will result in more and better benefits for smallholder farmers. Synergy in collaboration is needed between and among private and public institutions to bear more fruit by converging different technologies.

Does use of ICTs, particularly mobile applications, make the role of development agents redundant?

There might be a paradigm shift in the medium or container of information, i.e., from the horse's back to motorcycle to mobile. It is expected that there will be an expanding role for extension and development agents in the new agricultural knowledge ecosystem.

Is reorientation of budget needed from input supplies (seed and fertilisers) to ICTs and knowledge needed?

This paper examines whether reorientation of budget is needed from input supply (improved seed and fertilisers) to ICTs. For instance, Ethiopia is investing 10% of its national budget in agriculture, but most of this budget is going into input supply. To change the agriculture of ACP countries fundamentally, equal attention should be provided to budgets for applications of ICTs as budgets for seed and fertiliser. Hence, reorientation in budgeting will make a difference in transforming smallholder agriculture in ACP countries. Similarly, agricultural technologies have hardware aspects (e.g., seed) and software aspects (e.g., different

agronomic and management practices) but there is a tendency to focus more on the hardware aspect of technology (seed distribution) than software aspects.

Mobile applications in agriculture

The role of mobile phone in agriculture has never been in question in developing countries. Hence, the issue has migrated from whether to how. The idea of using mobile computing in agriculture (also known as mAgriculture) is a new concept in North America, while mAgriculture in the developing world has been known and written about for almost a decade (Woodill and Udell, 2012:4).

Mobile financial services are among the most promising mobile applications in the developing world. Mobile money could become a general platform that transforms entire economies, as it is adopted across commerce, health care, agriculture and other sectors (World Bank, 2012:61)

In terms of design we need to ask a few questions. Are mobile applications demand driven? Are these innovative mobile applications build by getting ample information from the demand side (smallholder farmers, cooperatives, rural youth, etc.)? It is good to raise such issues and discuss them adequately as it will help future mobile applications to be more applicable and demand driven, Put differently, we should take time and listen to the expectations of all actors involved in the agricultural sector.

Box 2. Start with the smallholder farmers when designing mobile applications

In order to have mobile applications which really meet the expectations of smallholder farmers, software or mobile application developers must ask smallholder farmers about the type of services and information (content) they want and in which format they want to have it in. At first glance, their feedback might seem ambitious or even funny, but for wise mobile application developers, their feedback is an indispensable input to design of mobile applications that work perfectly for smallholder farmers both now and in the future.

Mobile applications can be initiated by individuals, students, university staff and researchers, private computer dealers and software developers as well as development agents and farmers (as they have already been exchanging technical and market information within and between them informally and formally for years). Moreover, the government could take the initiative to curb the lack of market information among smallholder farmers. Governments have the capacity to scale up the use of mobile applications on a wider scale, either on its own or through different types of partnerships such as, public–public, public–private or private–private at the local, national, regional and international levels. In short, innovators of mobile applications could range from a single individual (student) to the government.

An increase in the number of mobile subscriptions or mobile applications is not enough. They should be evaluated against their content and their innate purpose. In other words, mobile applications should be evaluated in terms of the values that they add for smallholder farmers, how they bridge the (market) information gap and the extent that they reduce the uncertainty of farmers in terms of price and marketing information.

Attracting the youth into agriculture

Youth are the next generation of farmers. Involving the youth in agriculture is more than just replacing old farmers with young farmers; it is about rejuvenating the small-scale agriculture and re-emphasising its roles that it has for the nation. It is about infusing new blood into the agricultural sector. Involving youth in agriculture needs a change of mindset. We need political commitment and new insight supported with a clear vision and workable policies. It is about searching for scientific and technological (ICT-based) solutions for old problems. It's about building trust in youth and women. It's about considering the youth as today's partners and tomorrow's development architects. It's about building on what we have (on the indigenous knowledge and wisdom of old farmers) and believing in our future, the youth. After all, it is about intergenerational development. Above all, it is about winning the hearts and minds of the young people. This can only be possible if agriculture gets the right place and the attention that it deserves in society. Actually, after many years of neglect, agriculture once again has taken its rightful place in the world.

However, until very recently, a number of people in Africa had a distorted perception about farmers and agriculture. For them, farmers were considered to be backward. Even if it needs further study, we must question the perception of some professionals on agriculture. For instance, in Ethiopia, it has been more than half a century since agriculture launched as a field of study at the university level, but it is one of the fields that many students are reluctant to join. One of the reasons for this trend is that agriculture is not promoted adequately by the universities, agricultural professionals and by the government as a key field and discipline that shapes the future of the world. If governments and international partners recognise smallholder farmers and support them duly with scientific knowledge and appropriate ICTs (mobile applications) that enable them to get more return from their produce, they can surely change their livelihoods and gradually transform their nations. Indeed, one cannot deny that there are students who are joining agricultural fields in universities of their own volition. This is a good start. This is the picture that we have in our universities, but paradoxically currently rural youth are engaging in agriculture in Ethiopia in different areas. There is no need to tell them that agriculture is really a good business since they have been looking at the success of young farmers in their own vicinities and regions.

To attract the youth to get involved in agriculture, we need to make the agricultural profession ICT-based and a knowledge intensive sector. The youth need to see that agriculture is being transformed through modern ICTs. You have to show that you are ready to listen the rural youth before you start designing different ICTs and mobile applications.

Box 3. Design mobile applications for the future, not for now

If you design mobile applications for now, it means that the future design will look like now. Before you design different ICTs and mobile applications, it is good to approach rural youth to explain the type of mobile applications and how they want to use it. Once you collected all feedback, then design mobile applications, surely it will be useful for the future farmers (youth) if we start design from them. The future is today, so asking children and youth will help mobile applications or software developers to see the distant future and hence incorporate it into the design.

Box 4. "I am the son of farmer, but my children are the son of a professor"

Once upon a time, an Indian expatriate academic staff teaching in Haramaya University, Ethiopia, in one meeting, reflected his own life time observation as: "I am the son of farmer, but my children are the son of a professor." Now, I am to ask one simple question for all renowned personalities and professionals who reached a peak in the agricultural profession, which needs an honest answer: How many of us really recommend that our children or relatives should pursue their university education in agricultural fields? It is we who are in the agricultural profession that should be champions to appreciate and recognise the role of agricultural sciences for the betterment of the world. It is needless to mention that it is agriculture that changed the world; and equally as it is backbone for the economy and springboard to transform countries to an industry era; it is agriculture that will herald the renaissance of ACP countries, particularly African countries like Ethiopia.

Revisiting agricultural professionals' attitude toward agriculture

Push and pull factors to involve youth in agriculture

Pull factors

- A clear understanding about agriculture as a business
- Youth are exposed to agriculture activities worldwide through the internet and mobile phone
- Innovation is the brainchild of problems ("necessity is the mother of invention")
- Governments' policy is to involve the youth (particularly unemployed university graduates) in agriculture, both in rural and urban agriculture
- Credit access for agricultural activities

Push factors

- Many youth (particularly rural youth) are unemployed, even university graduates
- Rural youth lack skills and knowledge to compete and join different jobs in the urban areas
- To improve their livelihoods
- Lack of chance of alternative jobs

From the above, one can see that pull factors outweigh the push factors, for involvement of youth in agriculture.

Some youth are already involved in agriculture and as brokers (between farmers and wholesalers, in their respective rural areas), they know that currently agriculture is a good business that enable them to earn a lot. So, as some of them are already involved, what types of promotional activities are needed in such situations? One is not expected to promote agriculture as a business starting from scratch, as after all most Ethiopian youth are born and raised helping their father (farmer) in the rural areas.

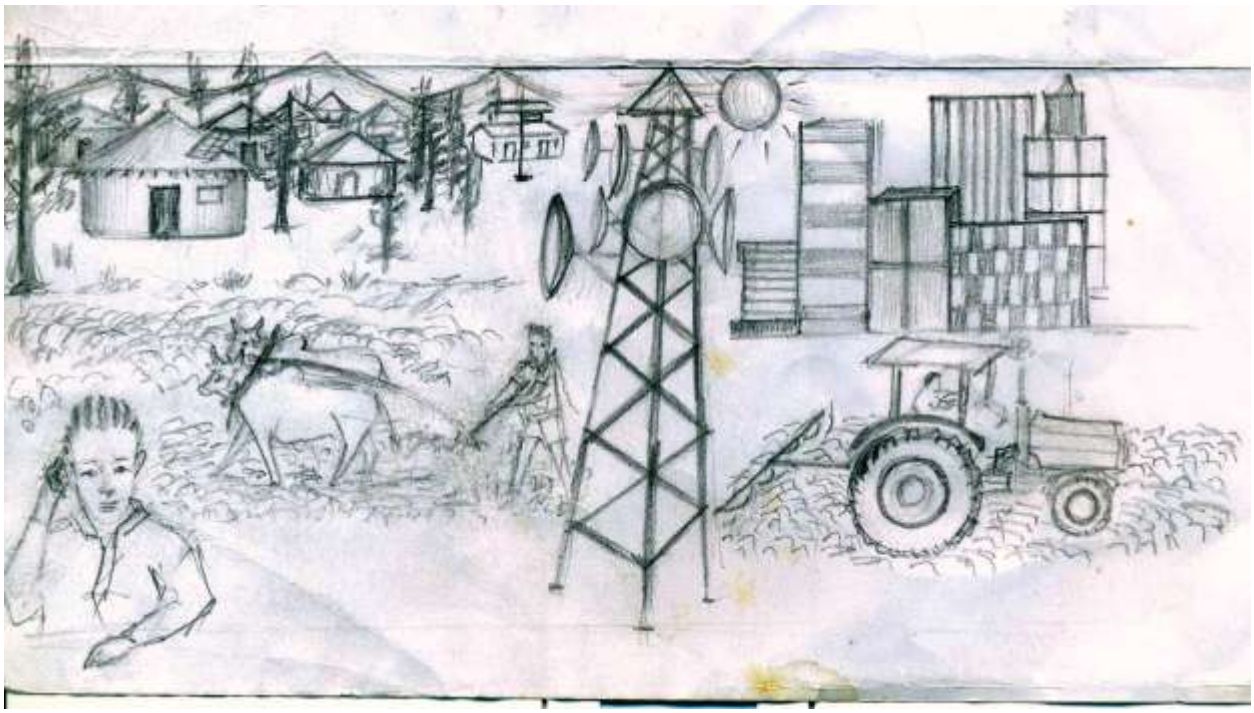

Plate 2. ICTs, particularly mobile applications can inspire smallholder youth and women farmers to see a bright future as the next generation of farmers.

Illustration by Samson Mammo, 2013

Lessons learned from mobile applications in agriculture

- Many mobile applications are launched in a business model, especially those that provide banking and micro financial services that are the result of collaborations between and among private and government bodies.
- Well-known mobile applications like M-PESA were launched following a student software development project. This implies that the youth can design our future; they can reshape our live in many ways. Similarly, we can involve youth (even in other professional fields) in agriculture by creating such chances to develop software or mobile applications that serve the agricultural sector, especially smallholder farmers. This is something that ACP countries can adopt to provide market information and knowledge to smallholder farmers and thereby link them with different markets.
- We learned that simple ideas can transform the world, let alone specific nations and sectors such as agriculture.
- Mobile applications developed in agriculture, provide information on different issues, such as soils, pests, markets, prices, extension messages etc.
- Most mobile agriculture applications are meant for users, from researchers to smallholder farmers. Indeed, many applications are devised primarily for rural people and/or farmers. However, mobile applications in agriculture have wider users.
- SMS is a well-used format to provide different types of agricultural information by mobile phone. Globally, it has been more than two decades since the first text SMS message was sent by mobile phone.
- Globalisation of mobile applications in agriculture, particularly to link farmers with markets need to consider the local context equally with what has been in place

worldwide. Once we consider both critically we can build mobile applications that really solve our different agricultural problems.

- Internationalisation of mobile applications in agriculture that initially launched at the local and national levels enabled applications like M-PESA to impart its legacy globally. Moreover, it enabled to reverse the conventional knowledge and technologies flow, i.e., from North to South, or from West to East. Such successful mobile applications will allow ACP countries, like African countries (and particularly Kenya), to disseminate knowledge and technologies the other way round, from South to North or from East to West.
- Mobile applications developed for other sectors could also be appropriately adopted for agriculture, particularly mobile applications to link farmers with markets.
- Mobile applications developed for different agricultural activities could also be adopted appropriately to enhance market access to farmers and above all to link farmers with markets.
- Smallholder farmers need market and technical information; mobile applications that will be developed should also recognise this as farmers are now moving from just having more produce to better returns. However, it seems that priority given in developing mobile applications is on providing technical information as an answer to all of the farmers' problems. So, when one decide to develop mobile applications for smallholder farmers, a fundamental relook is needed in order to consider equally the relevance of linking farmers to markets (market information) as well as providing technical information.
- Across the world, most available mobile applications are in English, not in local languages. There are some mobile applications like M-PESA which use regional languages like Kiswahili.
- Mobile money applications developed in Ethiopia are working in few local languages in addition to English.
- M-Birr is the first mobile money applications developed in Ethiopia to provide a banking service and microfinance institutions' activities to the public at large.
- There are various electronic market platforms on websites. Market information is also provided through the websites of commodity exchange offices of respective nations, such as Ethiopian Commodity Exchange (ECX), Kenya Agricultural Commodity Exchange (KACE), to mention a few. Almost all nations in ACP countries have the same purpose – to inform actors found in agricultural marketing value chains about the current and future trends of different commodities. Specifically, they developed electronic market platforms to provide up-to-date market information on bids, prices and trends and to enhance market transparency.
- Mobile phone applications in agriculture are late particularly in most African countries compared to other sectors like business, entertainment, education and health sectors. But late is better than never.
- Mobile applications are started to develop in Africa e.g., M-PESA. There are new applications like e-farming which were launched just last year.
- Great interest is shown from the private sectors (private mobile operators and software developers) to involve in the development of mobile applications for the smallholder farmers, particularly to link formers with markets and to provide alternative microfinance information and banking services. Actually, this is what has

been proved from the review of the above mobile applications. Indeed, they are doing it in partnership with other private, public and international partners.

General insightful observations

- Just like agricultural technologies, i.e., improved seeds (hard technology), should be supported by soft technologies (knowledge about agronomic dimensions). Similarly, just distributing mobile phone and SIM cards is not enough; government and other concerned officials need to work on preparing different applications for mobile phones to transform the lives of smallholder farmers.
- ICTs are not only changing the way smallholder farmers are working, but also change the way partners collaborate.
- From computing to communication: computing is not enough; we need to communicate and share information with different smallholder farmers, commercial farmers, rural youth and women and policymakers – both vertically and horizontally.
- Surprisingly, there is no “Not Invented Here Syndrome” in the adoption of ICTs particularly mobile applications. Farmers recognise its benefits.
- As a developing country, where we are in terms of mobile applications? At the acquisition, assimilation, improvement or creation stage? Currently we are acquiring technologies and applications and trying to develop our own mobile applications and electronic platforms that suit the information needs and information seeking behaviour of smallholder farmers. So, identifying the stage that we are at now will help us to develop appropriate mobile applications in agriculture, particularly to link farmers with markets. It will also help us not to make blanket recommendations for countries.
- The future of extension purely depends on ICTs.
- ICTs (mobile applications) either bridge or widen the digital divine. However, the key is in our hands.
- Involving youth in agriculture needs a change of mindset.
- Involving the youth in agriculture is more than just replacing old farmers with young farmers.
- From the discussion, it is clear that pull factors outweigh the push factors, to involve youth into agriculture.
- Nations can learn both from their past and future. So can organisations.
- It is a fact that unlearning old skills is more difficult than learning new knowledge and skills.

Learning from the future

As an individual, learning is a three-way process: for instance, I learn from you, you learn from me and we learn each other. Individuals learn from one another, similarly organisations and nations learn from each other. As we are living today in a globalised world that demands interdependent relationships, it is necessary to learn not only from our past, but also from our future. Indeed, it is true that unlearning is difficult for individuals, organisations and nations. So, sometimes more has to be done to unlearn old knowledge and skills than to acquire new knowledge and skills.

Learning organisations are open to outsiders. Open organisations are ready to change, since they are committed to sharing knowledge, skills and experiences, both vertically and horizontally between and among different actors at various levels.

The same holds true for agricultural organisations, such as the ministries of agriculture and rural development, institutes of agricultural research, extension organisations and the like. To be open and learn from other organisations found at national, regional and international levels means to be ready for change. Learning should occur both within and between organisations particularly with regard to ICT applications (especially mobile applications that link smallholder farmers to markets).

One can learn from failure or success. Indeed, it is good to learn from the past. Equally, individuals and nations can learn from the future. The future is today. Today, developing countries can learn a lot from the era that we are living now.

Even today knowledge is being considered as a national resource similar to the classical resources of land, labour and capital. Moreover, the future prosperity of a country will depend on its capacity for learning, i.e., the capacity of its people and policymakers to learn –to inspire, visualise, innovate and renovate new technologies and ideas, to co-create knowledge and technologies. This is, undoubtedly, the strategic element that can transform nations in a sustainable manner.

ICTs have changed the world into a global village. It has changed the way we work, communicate and share knowledge and information. It has changed the agricultural sector too. Thus, the future will also be characterised as one full of dynamic changes. Competitiveness will not always be guaranteed, as we must keep up with different technological trends and changes. Moreover, change is a continuous process and should be considered as a culture, not as a one-time task. In the ICT and knowledge ecosystem, change is unpredictable. We should be aware that in the future, technologies and concepts are evolving and being replaced at a very fast pace. To be effective in our engagements, we should realise that the future is today; it is not as such in the far distance.

Conclusion

We do not need to reinvent the wheel! Readiness to adopt innovative mobile applications already in place in different ACP countries outside of Ethiopia is vital to transforming smallholders, particularly young farmers. A kind of partnership should be established between universities, the Ministry of Agriculture, Ministry of ICTs, Ministry of Science and Technology and private software developers to design mobile applications that consider the existing situation of smallholder farmers in the respective developing country. Such partnership can be fruitful in a short period of time, since it is formed by and among well-established organisations. There is no a need to start everything from scratch.

Moreover, once governments recognise the relevance of mobile applications, it will not be difficult to make it a priority in the agenda. However, we should not forget that priority should be supported by an appropriate budget, because if you are not willing to allocate budget it shows that you are not convinced as to its relevance.

Our ultimate direction and move should be to enhance utilisation and bring significant impact that transform smallholders' lives in particular and countries in general. In the short term, this

will in turn, surely have a great impact in driving, for instance, ACP countries' development, whereas in the long-term, it will contribute to reducing the number of undernourished people found in the world. After all, if respective nations became self-sufficient in their food security, it means that they are reducing the world's burden.

The focus should not be only about the availability of ICTs (e.g., mobile phones and mobile applications), but we need to collaborate to increase accessibility and usability of ICTs, which means that partners (governments, international partners and private sectors) should consider the relevance and timeliness of content and the ease of use of the mobile applications. In this regard, international partners are working with international publishers and aggregators to provide access to e-information resources (scientific and technical information and knowledge) to researchers found in developing countries for free or at a reasonable cost (about 2% of the publishers' price). Similarly, they can adopt the same model and procedure with mobile applications developers to develop mobile apps that could really link smallholder farmers to markets.

Synergy among different actors is observed in developing mobile applications for farmers, particularly smallholder farmers. Collaboration and partnership at different levels (from local to international levels, from public to private collaboration, collaboration between and among NGOs, etc.) need to be nurtured in a responsible manner. Trust and synergy should be developed between and among both government and private sector actors; this is expected to produce a bright future for the smallholder farmers and for the world. Hence, it is good to think big, start small and keep growing. In so doing, we can move from availability to accessibility to usability and finally to use of mobile applications to link farmers to markets.

Solutions

In this paper, lessons learned from mobile applications in agriculture and general insightful observations are outlined. In this subsection, points that were not well covered above will be briefly discussed.

The user friendliness, benefits, portability and applications of mobile phones are increasing over time, while their size, price and weight are decreasing. This trend is good for smallholder farmers as it facilitates them in using mobile applications primarily to transform their lives; they can contribute their best to feed the world's undernourished people.

To attract and engage the youth into agriculture, bad impressions about agriculture, particularly among agricultural professionals, should be replaced with genuine and positive images of today's farmer; the indispensable role of agriculture in uplifting ACP countries in particular and the world in general from age-old problems such as poverty should be promoted to the youth.

Mobile applications in agriculture in Ethiopia is a new phenomenon, despite that there are many and various mobile applications in agriculture in many African countries in particular and ACP countries in general. So, as we are late in developing mobile applications, it is recommended to take the late movers advantage.

Sometimes it is good to be late as since it will give you a chance to learn from others' mistakes. You will get the opportunity to know the plus and minus sides of different mobile

applications that developed earlier to link farmers with markets and thereby you can develop your own applications that overcome perceived gaps in the predecessors' applications.

Particularly, in the area of ICTs where there are many dynamic changes and unpredictable trends, it is advisable to take the 'late movers advantage,' i.e., to develop mobile applications for agriculture, after checking the available tested and well-tried mobile applications globally and in ACP countries in particular. That is why, for instance, it is not always good or recommended to buy the top brand ICTs in the market. Similarly, the very reason to formulate ICTs policy that will be changed after a year or two is because there are full of dynamic changes in ICTs environment.

Most of the time, mobile application developers learned a lot from the previous developers. As Isaac Newton said, we developed new knowledge based on others' previous works. We build on what is already known, on what others have done. Similarly, mobile applications in agriculture, particularly to link farmers with markets are developed based on what others have already done.

Finally, we suggest that change should be considered to be a culture. Being first is not a big deal, but staying in that position sustainably is mandatory. Similarly, developing mobile applications for smallholder farmers is the right move, but it is better to review applications periodically so as to come up with more suitable mobile applications that serve not only the current information needs but also the future information needs of smallholder farmers.

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Appendix 1. List of mobile applications in agriculture, particularly those that link farmers to markets.

No.	Mobile applications	Who initiated?	Users	Uses & context(s)	Outreach & impact	Costs for users Affordable (1) Expensive (2) None (3)	Availability (1)[1] Accessibility (2)[2] Usability (3)[3]	Lessons learned
	Agro-Hub	Cameroon	Farmers	Market and price information, mob apps	Attract better prices and increase farmers' income	1	1, 2, 3	Updated and timely information convinced farmers to use mobile applications
	Agri-Fin mobile	Mercy corps	Farmers and rural people	In rural context	Improved financial services for rural people	3	1, 2, 3	Started small and keep growing
	CABI International	CABI	Farmers	Using photos they will see the disease of the plant and act accordingly.	Send plant doctors to meet farmers	3	1, 2, 3	Recognised contributions
	CTA	CTA	Wider users (from farmers to agricultural researcher	Depends on users and types of services and supports	Global, specifically in ACP countries	3	1, 2, 3 is different depending on the type of information	Not directly involved in developing mobile applications, but involved for more than a decade to create

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			s and policy makers)				and users	fertile ground to change the lives of farmers fundamentally. This has been approached in different ways and mechanisms (from provision of agricultural information to building the capacity of human power that can change the future agriculture of ACP counties).
	DrumNet	Kenya (Pride Africa)	Actors in value chains	An integrated platform that uses different ICTs (mobile phones) to provide an end-to-end solution to d/n actors in value chains	Implemented in 5 d/n Kenyan provinces Reached > 4,000 SHFs Serving different actors	1	1, 2, 3	1 t provinces level
	E-farming	Kenya	Farmers	Text message	Established last	3	1, 2, 3	Boast yields

No.	Mobile applications	Who initiated?	Users	Uses & context(s)	Outreach & impact	Costs for users Affordable (1) Expensive (2) None (3)	Availability (1)[1] Accessibility (2)[2] Usability (3)[3]	Lessons learned
				service – crop management, the right fertilisers to use	year,, by African Soil Information Services (AFSIS) Smallholder farmers are using it and even convinced by its use and are deciding to urge others to use it.			**If farmers are interested in the mobile applications developed they will urge others to use it**
	Esoko	Ghana (Tradenet)	Farmers	Access to market information – can place order to buy/sell	farmers witnessed a revenue increase since they began using Esoko SMS market prices at least 14 African countries are using it	1, 3	1, 2, 3	Impacts are continental
	e-vouchers	Malawi	SHFs	ICT platform/programme	improved efficiency & effectiveness in the distribution of farm input Electronic presence (enhance visibility)	1	1, 2	Limited users, but once they are convinced by the service will grow up gradually.

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	Farmers helpline	Kenya	Farmers	Information and advice on different agricultural issues	At a national level	3	1, 2, 3	This service attract farmers easily
	Grameen Bank mobile applications	Grameen Bank	SHFs	Different mobile applications which suites the smallholder farmers and rural poor	Global	3	1, 2, 3	Beyond the conventional microfinance services for the poor, still helping the poor in developing and implementing different mobile agriculture applications
	iCow	Kenya	Farmers, traders	Mobile phone cow calendar	Global recognition Winning mob apps in 2010, Africa competition. Help smallholder farmers to manage & trade livestock Farmers increase	1	1, 2, 3	Private-public partnership Collaboration of private companies, software developers/IT entrepreneurs, NGOs & governments

No.	Mobile applications	Who initiated?	Users	Uses & context(s)	Outreach & impact	Costs for users Affordable (1) Expensive (2) None (3)	Availability (1)[1] Accessibility (2)[2] Usability (3)[3]	Lessons learned
					milk production by over 50% & income by 42%			
	InfoDev	InfoDev (International partner)	Wider users	Depends on the type of users	Global	3	1, 2, 3	Provide opportunity for entrepreneurs to develop innovative mobile agricultural applications in Africa Providing agricultural knowledge and technologies in electronic platform (website) to transform agriculture particularly in developing countries
	Infotrade	Uganda	Farmers, traders and other actors	Infotrade provides critically analysed information collected from 20 district markets in Uganda covering	At districts and provinces level	1	1, 2, 3	Has opportunity to scale up in due course, they started small – which is advisable.

No.	Mobile applications	Who initiated?	Users	Uses & context(s)	Outreach & impact	Costs for users Affordable (1) Expensive (2) None (3)	Availability (1)[1] Accessibility (2)[2] Usability (3)[3]	Lessons learned
				a total of 46 commodities				
	KACE	Kenya	Actors in value chains	Provision of daily market, price and commodity transport related information	Update actors daily with d/n types of market-related information	1	1, 2, 3	Enhance market transparency & build trust between actors in the value chain
	KenCall	Kenya	Farmers	Extension messages and advice from experts	Providing information for your questions and concerns within one day	1, 3	1, 2, 3	Farmers believe in expert, so will be adopted easily Timely information
	Kilimo Hotline	Kenya	Farmers	Trade information via SMS. Market information Extension message	Offer agricultural insurance to farmers	1	1, 2, 3	Mix of market and extension messages will attract more farmers
	Kilimo Salama	Kenya	Farmers	Information about weather conditions	At national level, in some provinces	1	1, 2, 3	Provision of different types of information (like in one window)

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	KUZA Doctor	Kenya	Farmers	Farm to health, SMS text	Serving at a national level and in rural context	1	1, 2, 3	Provision of different types of information (like in one window)
	Life line	India	Farmers	Support and extension messages	Serving at a national level and in rural context	3	1, 2, 3	Adopted by the rural people well as it provide answer for their different technical questions
	Manobi	Senegal	Farmers	Fishing oriented data and information	Through different mechanism from PC to mobile on average, users get about 15% higher profits after they started using it	3	1, 2, 3	Private sector, i.e.,business model is likely model in mob apps
	M-Birr	Ethiopia	Different people	Mobile banking	To reach 1.5 million people in 3 years time	3	1, 2, 3	Even if Ethio Telecom is the only mobile operator, it is good practice to invite private PLCs to develop such mob apps

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								More mobile money applications are coming
	mFarmer	GSMA	Farmers	Critical agricultural information	Has phase 1 (May 2011 – Sept 2014) – to reach > 2 million poor smallholder farmers to obtain critical agricultural information Phase 2 – on mNutrition	1	1, 2, 3	Partnership among international partners and governments (The Initiative is supported by the Bill & Melinda Gates Foundation, USAID & UK Government))
	M-Farms	Kenya	Farmers and other actors	leader in connecting a network of farmers involved in selling online their fresh products & makes possible to purchase by sending oral	Global recognition real-time market information for smallholder farmers (SHFs)	1	1, 2, 3	Private-public partnership Collaboration of private companies, software developers/IT entrepreneurs, NGOs & governments

No.	Mobile applications	Who initiated?	Users	Uses & context(s)	Outreach & impact	Costs for users Affordable (1) Expensive (2) None (3)	Availability (1)[1] Accessibility (2)[2] Usability (3)[3]	Lessons learned
				voice or SMS to the phone number				
	M-KESHO	Kenya	Farmers and others	Payment service You have to be M-PESA user to use it	Expand range of mobile financial options available to rural households Unbanked people are getting bank account and services significantly	1	1, 2, 3	Collaboration of Safaricom and Equity bank (private–private partnerships) Unbanked people are getting bank account and services significantly. This will complement the effort of the government banks and also will reach the unreachable rural people.
	M-PESA	Kenya	Wider users (not only farmers)	Mobile many transfer & microfinancing service	Reached almost all over Africa Globally recognised Reached six countries, over 20 million users, transfer on average	1	1, 2, 3	**Expanded (Replicated)** in different countries Even microfinance professionals from the developed countries & giant international

No.	Mobile applications	Who initiated?	Users	Uses & context(s)	Outreach & impact	Costs for users Affordable (1) Expensive (2) None (3)	Availability (1)[1] Accessibility (2)[2] Usability (3)[3]	Lessons learned
					> US$500 million in a month time Seems almost online banking system, so wider users and impacts Farmers can pay for workers and different input supplies, so facilitate the supply of inputs greatly.			partners like Gates Foundation were ready learn how it works) **(knowledge & experience sharing from South to North)** **Collaboration of mobile operators** like Safaricom & Vodafone and **funding from international partners** **Students can make a difference** in designing software/mobile application **Other applications like M-KESHO are developed**
	NMRice Mobile	IRRI (started in Philippines in 2011)	Farmers and extension	Free fertiliser guidelines for rice They only expect	Nutrient Manager for RiceMobile	3	1, 2, 3	Prevent loss of yield that can result from inappropriate use of

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			workers	to call a toll-free number				fertilisers
	SALI (Sustainable Agricultural Livelihood Innovation)	Mbeere, Embu by Christian Aid	Farmers	Information on weather updates, by mobile	In some provinces	3	1, 2, 3	NGOs are involving in mobile applications
	SANGONet	East Africa	Small-scale dairy farmers	Record lactation history of their cows	Better health for their cows & increase income	1	1, 2, 3 depending on different factors	In Africa, livestock is also big sector, need to be covered in such applications
	Sokoni SMS 64	Kenya	Wider users (not only farmers)	Text messaging platform	Reached peoples in millions	3	1, 2, 3	They started small and keep growing
	VillageCel	India	Farmers and others	Affordable services in the rural areas	Localised, free, cellular connectivity, alternative to the high-end mobile-phone networks	1	1, 2, 3	Cost effective

Note:

[1] Availability – indicates that mobiles (mob apps) are made available to smallholder farmers; it doesn't indicate that smallholder farmers bought (access it or owns it either by himself/herself or through different support and arrangements), or used it for different purposes.

[2] Accessibility – indicates that mobiles (mob apps) are made available to smallholder farmers and he/she access or owns it. Accessing or having it doesn't necessarily mean that smallholder farmers are using it as there are many factors such as cost, language, network access, bandwidth, relevance of content, relevance of mobile applications, user friendliness (easy to use) of mobile applications, etc. that stop them using it effectively, particularly to link them with different markets at local, national, regional and international level.

[3] Usability- indicates that smallholder farmers are practically using mobiles (mob apps), particularly to link them with different markets at local, national, regional and international level.

SHFs = Smallholder farmers

Note: Refer to lessons learned from mobile phone applications in the main paper

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