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RESEARCH ARTICLE

IMPACT OF MOBILE PHONE TECHNOLOGY ON AGRICULTURE AND RURAL DEVELOPMENT: AN ANALYSIS

***Dr. Paul Mansingh, J. and Mr. Fikadu Abdese Erena**

Department of Rural Development and Agricultural Extension, Ambo University, Ambo, Ethiopia

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ABSTRACT

Mobile delivery of extension information is an idea whose time has come, as this represents the most cost-effective and widespread interactive delivery medium. Communication through mobile phones is not a replacement of traditional communication tools, but compliments and facilitates the process of dissemination. Mobile phone usage by farmers can reduce the information search costs, thereby dramatically lowering transaction costs and enabling greater farmer participation in commercial agriculture. It is very much imperative to know the impact of mobile phone technology in the field of agriculture and rural development. This knowledge will help to redesign the existing transfer of technology programmes in such a way by utilising the mobile Phone technology so that the knowledge will be disseminated in an efficient and better way. The research design employed was 'Secondary data analysis' which is an analysis of data that has previously been collected and tabulated by other sources. Various research studies, project reports and conference proceedings were analysed to document the impact of mobile Phone technology in agriculture and rural development. To be included in the review, projects had to be specifically focused on mobile phones. To fit in the protocol, projects had to offer sufficient details around the use of mobiles to illuminate their role in the development processes. The impact of mobile Phone technology was analysed in the following fields: Agriculture, Rural Health, Rural Finance, Rural Development, Education and Natural Disaster Management. The impact was visible in all the fields analysed and therefore, it is more important to communicate the information needed by the local communities in a way they can grasp and act upon. Mobile Phone technology will unlock enormous benefits for the agricultural and rural development sector, particularly in the developing world.

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INTRODUCTION

ICT is any device, tool, or application that permits the exchange or collection of data through interaction or transmission. ICT is an umbrella term that includes anything ranging from radio to satellite imagery to mobile phones or electronic money transfers. The increases in their affordability, accessibility, and adaptability have resulted in their use even within rural homesteads relying on agriculture. New, small devices (such as multifunctional mobile phones and nanotechnology for food safety), infrastructure (such as mobile telecommunications networks and cloud computing facilities), and especially applications (for example, that transfer money or track an item moving through a global supply chain) have proliferated. Many of the questions asked by farmers (including questions on how to increase yields, access markets, and adapt

to weather conditions) can now be answered faster, with greater ease, and increased accuracy. Many of the questions can also be answered with a dialogue—where farmers, experts, and government can select best solutions based on a diverse set of expertise and experience. The types of ICT-enabled services that are useful to improving the capacity and livelihoods of poor smallholders are growing quickly. One of the best examples of these services is the use of mobile phones as a platform for exchanging information through short messaging services (SMS). Mobile delivery of extension information is an idea whose time has come, as this represents the most cost-effective and widespread interactive delivery medium (Ramamritham et al. 2005). Communication through mobile phones is not a replacement of traditional communication tools, but compliments and facilitates the process of dissemination. The expansion of mobile phone networks and increase in mobile-density in Uganda has enabled higher market participation by farmers producing perishable crops located in remote areas and helped them realise higher prices by reducing

*Corresponding author: Dr. Paul Mansingh, J.

Department of Rural Development and Agricultural Extension, Ambo University, Ambo, Ethiopia.

the information asymmetry that existed between farmers and traders (Muto and Yamano, 2008). Mobile phone usage by farmers can reduce the information search costs, thereby dramatically lowering transaction costs and enabling greater farmer participation in commercial agriculture (DeSilva and Ratnadiwakara, 2008). It is very much imperative to know the impact of mobile phone technology in the field of agriculture and rural development. This knowledge will help to redesign the existing transfer of technology programmes in such a way by utilising the mobile Phone technology so that the knowledge will be disseminated in an efficient and better way.

MATERIALS AND METHODS

The research design employed was 'Secondary data analysis' which is an analysis of data that has previously been collected and tabulated by other sources. Secondary data was available at a level of analysis suitable for answering the researcher's questions. Various research studies, project reports and conference proceedings were analysed to document the impact of mobile technology in agriculture and rural development. Papers were initially identified by online literature and database searches (using keyword combinations of mobile, cellular, agriculture, rural development, etc.), and by snowball references from the bibliographies of studies already in hand. To be included in the review, projects had to be specifically focused on mobile phones. To fit in the protocol, projects had to offer sufficient details around the use of mobiles to illuminate their role in the development processes.

Findings and Discussion

The impact of mobile phone technology was analysed in the following fields:

1. Agriculture
2. Rural Health
3. Rural Finance
4. Rural Development
5. Education
6. Natural Disaster Management

Impact of Projects on Agriculture

The impact of projects on agriculture in which mobile Phone technology was used are analysed from various web sites and are presented in Table 1. From the analysis it was found that the farmers had access to needed information, changed information sourcing behaviour, gained knowledge, reduced costs, adopted best practices, got increased yields, improved the productivity, showed better market negotiation, resulted increase in price realisation, got increase in profits and increased income.

Impact of Projects on Rural Health

The details of the projects on rural health in which mobile phone technology was used were collected, analysed and presented in Table 2. The mhealth programmes implemented had the following impacts: improved information sharing and communication between community health workers and

district-level teams becomes cheaper and efficient, significant decrease in maternal and child mortality was observed, more people were tested for HIV/AIDS than conventional outreach methods, confidential and anonymous services were provided to HIV patients, learned new information about new born care, brought their new born to the Health Centre, passed on the information to other caregivers, resulted in safe pregnancy and healthy baby.

Impact of Projects on Rural Finance

The impact of projects using mobile Phone technology on rural finance was analysed and furnished in Table 3. The income of rural houses who adopted the service increased. The transaction costs for financial institutions decreased. More efficient and secured payments for members was ensured.

Impact of Projects on Rural Development

The impacts of projects on rural development were studied and presented in Table 4. The impact were visible in achieving huge efficiency improvements in data collection by using mobile-enabled data collection methods, providing information to citizens on government services and enabling citizens to provide feedback and complaints.

Impact of Projects on Education

The impact of projects on education are furnished in Table 5. The impacts on the education sector were: the answers are provided on time, very useful, convenient and helped teachers and students to solve difficult queries, pupils in the public schools are now updated with the latest trends/innovations in education and making and building self-confidence in them to be globally competitive.

Impact of Projects on Natural Disaster Management

The details on the impact of projects on natural disaster management are presented in Table 6. The usage of mobile applications in forecasting and disaster risk management facilitated delivery of timely and appropriate intervention, maximized allocation and mobilization of resources and saved many lives.

Conclusion

It was concluded on analysing the impact of mobile phone technology in agriculture that the farmers had access to needed information, changed information sourcing behaviour, gained knowledge, reduced costs, adopted best practices, got increased yields, improved the productivity, showed better market negotiation, resulted increase in price realisation, got increase in profits and increased income. As a result of mhealth programmes, information sharing was improved and communication between community health workers and district-level teams becomes cheaper and efficient, significant decrease in maternal child mortality was observed, more people were tested for HIV/AIDS than conventional outreach methods, confidential and anonymous services were provided to HIV patients, learned new information about new

Table 1. Impact of Projects on Agriculture

S.No.	Project	Impact	Source
1	Grameen Foundation, Uganda Give smallholder farmers access to accurate, timely information that helps them protect their crops and animals, improve their yields and get better market prices.	Ugandan farmers' adoption of best practices increased by 17%; in one case, the use of best practices increased by 31% compared to just 1% in control villages.	http://www.grameenfoundation.org/where-we-work/sub-saharan-africa/uganda
2	8Villages, Indonesia 8Villages offers robust, cloud-based carrier-grade messaging platform, allowing real-time communication between headquarters and rural customers. It enables to initiate a conversation via SMS, MMS, push notification for providing best practices.	By creating opt-in opportunities across their entire marketing funnel, Bayer Crop Science achieved a high opt-in rate and quickly developed a viable mobile community. - 95% of approached farmers opted-in - 30% of users directly interacted with the brand - 20% of farmers enjoyed and redeemed points at the local points of sale	http://www.8villages.com/
3	Farmer Information Super-highway, Thailand A subscription-based service, *1677 Farmer Information Superhighway sends farmers a daily SMS containing updated agricultural information on market trends, commercial crops, new farming techniques, farming tips, important news, and warnings on weather conditions.	By using this service, farmers gained knowledge to advance their farming skills and techniques that help them improve productivity, reduce costs, and increase income while also getting maximum benefits from mobile phone usage.	http://www.telenor.com/sustainability/initiatives-worldwide/using-mobile-to-improve-farming-skills/
4	AvaajOtalo, India Provides relevant and timely agricultural information to farmers over the phone using IVR.	Demand for agricultural advice is high, with more than half of farmers called Avaaj Otalo in the first seven months. Farmers offered the service turn less often to other farmers and input sellers for agricultural advice. There was an increase in the adoption of more effective pesticides and reduced expenditure on less effective and hazardous pesticides. Treated farmers also sow a significantly larger quantity of cumin, a lucrative but risky crop. Farmers appeared willing to follow advice without understanding why the advice is correct: the average respondent did not demonstrate improved agricultural knowledge, though there is some evidence educated farmers learn from the service.	https://awaaz.de/blog/2013/01/avaaj-otalo-impact-analysis-farmers-adopting-better-practices/
5	Fasal, India Fasal empowers rural farmers by providing current price information on agricultural products on demand through SMS text messages.	Over 700,000 farmers have used this program, with more than 8,000 farmers signing up for the service every week.	http://www.medianama.com/2012/04/223-intuit-offers-sms-alerts-for-farmers-through-fasal/
6	Mkrishi, India Platform uses mobile technology to cater to the absolute needs of the rural sector. It offers personalized advisory services in voice and visual using communication devices like mobile phones.	Increased farmer access to needed information, goods and services that improve their livelihoods, and which were previously costly or unavailable.	Padma (2013)
7	LifeLines-Agriculture, India The LifeLines-Agriculture service provides information on topics from production to consumption, including farm inputs, funding schemes, government schemes on loans and subsidies, banking and insurance, market prices, region-specific market information, agricultural news, and organic farming.	This has increased their knowledge on improved farming and animal husbandry techniques, leading to increase in farm outputs, and consequently enhanced their earning capacities. Better profits and improved crop productivity to the tune of 21% year-on-year provide the numbers to show how LifeLines has been of help; while farmers themselves attest to qualitative betterment in their life-standards as a corollary of the economic gains.	http://lifelinesindia.net/agriculture/successstories
8	Nokia Life Tools Nokia Life is an SMS based, subscription information service designed for emerging markets which offers a wide range of information services covering healthcare, agriculture, education and entertainment.	As of November 2012, more than 85 million people have used Nokia Life (across all of its services). Nokia claims that user feedback shows better market negotiation and 10%-15% increase in profits for farmers in India has resulted from the service.	https://agrilinks.org/sites/default/files/resource/files/Nokia_Life_profile.pdf
9	Nutrient Manager for Rice (NMRice), Indonesia Provides farmers in Indonesia and the Philippines with fertilizer advice matching their particular farming conditions. NMRice is a computer- and mobile phone-based application;	The International Rice Research Institute (IRRI) in mid-July 2012 estimated that Indonesian farmers could earn an added net income of 100 US dollars (USD) or more per hectare per season. Farmers in all provinces increased their rice yields and their net income when switching from their current fertiliser practice to the practice recommended by PHSL. In most cases, the net increase in income for farmers exceeded USD 100 per hectare per season.	http://www.rural21.com/english/private-sector-initiatives/detail/article/indonesia-fertiliser-advice-via-mobile-phone-0000393/

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10	Reuters, India Market Light for example, services over 200,000 smallholder subscribers in 10 different states in India for a cost of US\$ 1.50 per month. The farmers receive four to five messages per day on prices, commodities, and advisory services from a database with information on 150 crops and more than 1,000 markets.	5-25% increase in income of RML Subscribers interviewed. 8% increase in price realization for RML subscribers who sold directly to traders. 80% of farmers changed information sourcing behaviour after using RML. 90% of farmers believed they benefited from RML service, over 80% willing to pay for the same. 12% reduction in price dispersion across markets due to availability of RML service.	http://www.rmlglobal.com/impact.html
11	Pinoy Farmers' Text Center A SMS based helpdesk and customer support, which aims to link experts, extensionists, and farmers by answering rice-related queries through text messaging.	Increased farm productivity and profitability; Provided new knowledge and information.	http://www.philrice.gov.ph/about-us/philrice/
12	M-agriculture, India ATIC (Agriculture Technology Information Centre) of the KAU (Kerala Agricultural University) initiated a project on M-agriculture in 2011 using the e-SMS platform developed and offered by Kerala State IT Mission. ATIC had been sending short agricultural messages of 160 characters, twice a week, to around 12,500 farmers across the state of Kerala.	The messages were found to be appropriate and timely. The messages managed to urge farmers towards decision making and action. In the study, 72.8% have decided to adopt the communication passed on to them.	Sreevalsan et al. (2012)
13	KACE, Kenya The Kenya Agricultural Commodity Exchange Limited (KACE) is a private sector firm launched in Kenya in 1997 to facilitate competitive and efficient trade in agricultural commodities, provide reliable and timely marketing information and intelligence, provide a transparent and competitive market price discovery mechanism and harness and apply information and communication technologies (ICTs) for facilitating trade and information access and use.	The proportion of farmers and traders that say their incomes has increased and their bargaining positions have improved is very high (75% farmers and 60% commodity traders).	http://www.kacekenya.co.ke/
14	VirtualCity (G-Soko) G-Soko is a process that involves a collection of apps that allows users of the apps to manage inventory (Warehouse and Generator), trade produce (Trade portal & Clearing and Settlement) and request for bank loans (Bank Portal). The platform also provides an app for payments of services (Voucher) and farmer's data collection (Researcher).	Farmers received faster and more accurate price, quality, and quantity information.	http://www.virtualcity.co.ke/what-we-do/
15	1920 Agri Extension, Sri Lanka Toll-free hotline service that provides crop advisory and technology advice to farmers in Sinhala and Tamil languages.	Most of the farmers used ICT tools to obtain information on pests and diseases control, agro chemicals, and new cultivation methods. There was a significant effect on improvement of farmers' knowledge to reduce pests and diseases.	http://dl.lib.mrt.ac.lk/handle/123/8436
16	e-Dairy, Sri Lanka The project is part of the effort by the country's Information and Communication Technology Agency (ICTA) to improve livelihoods of the rural community. Mobile Phone technologies have been introduced such that Sri Lanka's dairy farmers can achieve self-sufficiency in milk production.	The farmers those who have registered under eDairy accessed the information/request services by using SMS on a mobile phone/CDMA phone from anywhere. "For example, a really good use for this is in artificial insemination of cattle," Ms. Mubarak said.	http://edairy.lanka.blogspot.com/ http://www.thedairysite.com/news/29050/dairy-farmers-linked-through-mobile-phones/

Table 2. Impact of Projects on Rural Health

S.No.	Project	Impact	Source
1	K4Health project, Malawi	Improved information sharing and communication between community health workers and district-level teams were four times cheaper and 134 times more efficient for receiving feedback than the typical method of travelling to meet with district-level supervisors directly.	https://www.k4health.org/projects/malawi
2	m-health project, Guatemala m-health initiative is based on the provision of a cell phone to community facilitators.	The project has demonstrated a statistically significant decrease in maternal mortality ($p < 0.05$) and in child mortality ($p = 0.054$) in the intervention group compared with rates in the control group. As a result of the telemedicine initiative, the intervention areas, which were selected for their high maternal and infant mortality rates, currently show maternal and child mortality indicators that are not only lower than the indicators in the control area, but also lower than the provincial average (which includes urban areas).	http://www.ncbi.nlm.nih.gov/pubmed/25766857

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3	Fansipan Challenge, Vietnam Fansipan Challenge is an SMS-based service developed by USAID's Sustainable Management of the HIV/AIDS Response and Transition to Technical Assistance (SMART TA) project.	During the trial period 68% of people participating in the challenge got tested for HIV/AIDS, compared to 18% in conventional outreach.	http://vietnamnomadtrails.com/en/2-days/73/03-days-adventure/290/fansipan-challenge.html
4	Voice4U, Cambodia This is an interactive voice response system that provides callers with on-line counselling, on-demand HIV and health-related information, and medication and appointment reminders.	The new mHealth platform offered confidential, anonymous services to people who may not be served through other means.	http://cambodia.usembassy.gov/052015_pr2.html http://health2615.rssing.com/channel/17973612/all_p8.html
5	PIN mHealth program, Cambodia This programme disseminates seven voice-messages in a period of four weeks, which equates to one message being sent every three days. The topic of the messages is the care of new born babies (focusing on the first vulnerable period of life, hence a four week long pilot program.	Of participants surveyed, 45% reported learning new information about new born care and 43% reported they brought their new born to the Health Centre as a result of listening to the messages. In addition, 70% of mothers reported they had given the messages to other caregivers (fathers, grandmothers, etc.) to also listen to.	http://www.mobilemamaalliance.org/sites/default/files/PIN%20Spotlight.pdf
6	LigaInan (Mobile Moms), Timor Leste LigaInan is using mobile phones to connect expectant mothers with health providers in Timor-Leste to improve the likelihood of a healthy pregnancy and birth.	Reminders encouraged them to attend the four prenatal visits that are recommended for full coverage of services. As a result, many women got good advice and support to improve their chances of a having a safe pregnancy and healthy baby.	http://www.ligainan.org/

Table 3. Impact of Projects on Rural Finance

S.No.	Project	Impact	Source
1	M-Pesa, Kenya M-Pesa (M for mobile, pesa is Swahili for money) is a mobile phone-based money transfer, financing and micro financing service, launched in 2007 by Vodafone for Safaricom and Vodacom, the largest mobile network operators in Kenya.	In rural Kenyan households that adopted M-PESA, incomes increased by 5-30%.	http://www.economist.com/blogs/economist-explains/2013/05/economist-explains-18
2	KilimoSalama, Kenya	Farmers in first year insured 10-20% of their inputs and increased insurance to 50% of inputs the next year.	http://siteresources.worldbank.org/INFORMATIONANDCOMMUNICATIONANDTECHNOLOGIES/Resources/MobileApplications_for_ARD.pdf
3	DrumNet, Kenya	Bank creditworthiness increased due to secure produce supply contracts. Reduced transaction costs for financial institutions. Kenyan farmers have been earning as much as 40% more for their crops – a rate of return which makes the service a very good investment.	http://siteresources.worldbank.org/INFORMATIONANDCOMMUNICATIONANDTECHNOLOGIES/Resources/MobileApplications_for_ARD.pdf http://p2pfoundation.net/DrumNet_and_the_Impact_of_Mobile_s_on_Kenyan_Farmers
4	b2bpricenow.com, Philippines	More efficient and secure payments to members.	http://siteresources.worldbank.org/INFORMATIONANDCOMMUNICATIONANDTECHNOLOGIES/Resources/MobileApplications_for_ARD.pdf

Table 4. Impact of Projects on Rural Development

S.No.	Project	Impact	Source
1	Catholic Relief Services, Central African Republic	Achieved huge efficiency improvements by switching to mobile-enabled data collection methods.	http://www.crs.org
2	TXT CSC, Philippines SMS-based service to provide citizens with a weapon, a tool to pressure government agencies into examining their systems and procedures towards faster and more efficient delivery of services.	Provided information to citizens on government services and enabled citizens to provide feedback and complaints. Complaints are sent by SMS, voice, and other means, then routed to the appropriate agencies.	http://www.egov4dev.org/mgovernment/resources/case/txtcsc.shtml

Table 5. Impact of Projects on Education

S.No.	Project	Impact	Source
1	Lifelines Education, India This is enabling critical academic guidance and pedagogic advisory to rural school teachers across Rajasthan - aiding them in course of their day-to-day teaching-processes in the classroom, and helping improve the quality of learning for their students.	The answers are provided on time, very useful, convenient and helped teachers and students to solve difficult queries which are otherwise not as easily resolved.	http://lifelines-india.net/education/successstories
2	Text2Teach, Philippines This is a learning package that uses mobile technology to download education videos for Grades 5 and 6 students in the subject areas of English, Math, Science and Values Education.	Pupils in the public schools are now updated with the latest trends/innovations in education, making and building self-confidence in them to be globally competitive. Teachers expressed that they are finding it easier to motivate, explain and enrich their English, Math and Science lessons.	http://www.text2teach.org.ph/?page_id=2

Table 6. Impact of Projects on Natural Disaster Management

S.No.	Project	Impact	Source
1	Surveillance in Post Extreme Emergencies and Disasters (SPEED), Philippines This is an early warning disease surveillance system for post-disaster situations. SPEED is an early warning surveillance tool that monitors health conditions and trends after an emergency or disaster using SMS and web-based applications.	Real-time reporting at all levels. Facilitated delivery of timely and appropriate intervention. Prioritized and maximized allocation and mobilization of resources.	https://interagencystandingcommittee.org/system/files/legacy_files/WHO%20SPEED%20Presentation.pdf
2	Nationwide Operational Assessment of Hazards (NOAH), Philippines The app updates users on rain forecast, weather outlook, and weather station summary features from data from the Department of Science and Technology (DOST) and its participating agencies.	Big improvements in the early warning systems have saved many lives. More than 167,000 people have been evacuated to shelters.	https://www.unisdr.org/archives/29954

born care, brought their new born to the Health Centre, passed on the information to other caregivers, resulted in safe pregnancy and healthy baby. The income of rural houses who adopted the service increased. The transaction costs for financial institutions decreased. More efficient and secured payments for members was ensured. The impact were visible in achieving huge efficiency improvements in data collection by using mobile-enabled data collection methods, providing information to citizens on government services and enabling citizens to provide feedback and complaints. The impacts on the education sector were: the answers are provided on time, very useful, convenient and helped teachers and students to solve difficult queries, pupils in the public schools are now updated with the latest trends/innovations in education and making and building self-confidence in them to be globally competitive. The usage of mobile applications in forecasting and disaster risk management facilitated delivery of timely and appropriate intervention, maximized allocation and mobilization of resources and saved many lives. The impact was visible on all the fields analysed and therefore, it is more important to communicate the information needed by the local communities in a way they can grasp and act upon. Mobile Phone technology will unlock enormous benefits for the agricultural and rural development sector, particularly in the developing world.

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