Options and Strategies for Information and Communication Technologies within Agricultural Extension and Advisory Services

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OPTIONS AND STRATEGIES FOR INFORMATION AND COMMUNICATION TECHNOLOGIES WITHIN AGRICULTURAL EXTENSION AND ADVISORY SERVICES

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The Modernizing Extension and Advisory Services (MEAS) Discussion Paper series is designed to further the comparative analysis and learning from international extension efforts. The papers contain a review of extension and advisory service best practices drawn from the global body of experience in successfully reaching resource-limited farmers. The papers identify the underlying principles associated with high levels of success in reaching women and men farmers and how, in differing contexts, these core principles have been successfully adapted to fit local conditions in establishing productive, profitable and sustainable relationships with individual producers, producer groups, the private sector and associated research and education institutions.

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The Editors,

Brent M. Simpson, Michigan State University, and
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Introduction: What is the purpose of ICT

The term "ICT" has been around since the 1980s, when it was popularized in the United Kingdom. ICT is different from information technology (IT) because it stresses the role of communications and the integration of telecommunications networks and computer networks.

The communications component is critical when designing and delivering technology that is meant to widen dissemination among communities, deepen understanding for individuals and increase democratization of information which allows more people to provide and access information.

Communication is a primary human activity. In the most basic form, it can be described as sending and receiving a message. The roles and activities are a sender, a message, a receiver and feedback. Shannon (1948) is credited with providing a basic description of the elements of communication. The diagram at right shows the general flow and parts of the process.

The diagram (Figure 1) is very basic, so it is necessary to describe the process further. For every sender there is context. The context of the message is how it is encoded or prepared for the receiver. Thus the sender's role, previous knowledge, biases and credibility all affect the message. How the message is decoded is also unpredictable because the sender doesn't always understand the characteristics of a receiver.

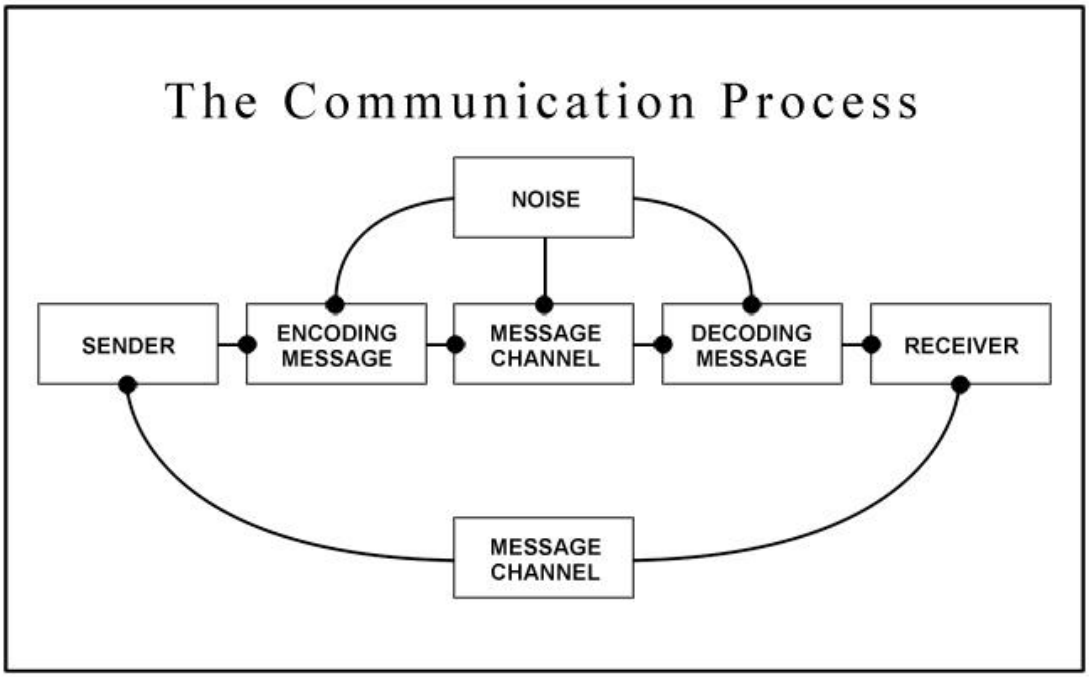

Figure 1. The Communication Process (Shannon, 1948)

The complexity in the simple communications model is easy to underestimate. The message combines information and can be delivered through technology. The methods used for information and technology can be altered at any point in the process. Information and communication technology (ICT) represents an opportunity to enhance the communications process by selecting the technology that makes the information more understandable to the receiver.

Communication technology can also influence the process, especially if the sender or receivers are using different tools. This can happen when the sender is using tools that the receiver does not have access to or if the receiver is able to receive information only in a certain format. For example, the receiver is not literate or has no access to technology, including radios or phones. For extension and advisory services to utilize ICT effectively, the designers of communication must plan with the end user in mind.

This discussion paper will cover the important role of ICT in the provision of extension and advisory services (EAS). EAS have been defined as "the dissemination of expert agriculture knowledge and practices" (Toyama, 2011). The communication from extension and advisory services is complex because it comes from many sources -- government, universities, NGOs, private sector companies -- and it involves not just information but hands-on communication. Many of the farmers who need to be served in developing countries are illiterate. The information conveyed through extension consists of data (information), knowledge (simple skills), training (advanced skills and techniques) and education (where use of information requires critical thinking).

Further complications arise from the fact that the number of ICT tools is growing and tools are constantly changing. Extension agents and their organizations are faced with a myriad of ICT choices of tools, from simple to sophisticated. Many in the EAS field are requesting research and evaluation of these tools before funds are spent, perhaps unwisely -- the results of many pilot programs vary and seem less than sustainable. Given ICT's impact in developing countries, it seems likely that funders and governments will continue to expect inclusion of ICT tools and technology as a means of improving EAS. Given the pervasiveness of technology, it becomes critical for practitioners to understand ICT so that they can align technology options and strategies to design effective communication for farmers.

Communicating to the target populations —Learning how to adjust the message

Extension and advisory services are complex. The training and advising could take place through multiple messages for multiple participants from multiple senders. Given the number of targets and the typically limited resources, understanding the target population becomes all that much more important for both staff members and donors. Designing effective communication to rural and development populations has been described well in a recent FAO document.

> *"**Rural communication** is an interactive process in which information, knowledge and skills, relevant for development are exchanged between farmers, extension/advisory services, information providers and research either personally or through media such as radio, print and more recently the new 'Information and Communication Technologies' (ICTs). In this process all actors may be innovators, intermediaries and receivers of information and knowledge…"* (Del Castello & Braun, 2006)

What the FAO statement fails to reveal is that well-designed ICT methods allow for almost an instantaneous adjustment of the message. In a well-designed repository of information, critical knowledge is tagged by audience level, amount of information and method of communication needed for an appropriate response. Aker (2011), FARA (2009) and Woodard (2012) all discuss how mobile phones can connect to agricultural information call centers. The information provided can be customized on the basis of information about the caller and changes in agricultural conditions. This is quite typical of call centers in developing countries. It's uncertain whether a return on investment can be determined and whether there is a way to sustain these approaches after original funding is spent.

Extension agents have for many years altered messages on the basis of the receivers' comprehension and need for information. The need to customize information on the basis of farmers' knowledge should be incorporated into the principles that guide ICT design. The design of the Kenyan National Farmers' Information Service, www.nafis.go.ke, for example, allows for extension agents to modify information on the basis of local conditions (FARA, 2009). The variations of the customization lead to a multivariate set of responses, some of which can lead to negative interactions. An example is the case of a poorly trained agent who has been repeating outdated information. The ICT framework would help the poorly trained agent communicate up-to-date information and customize it in the form of illustrations for illiterate farmers and as technical documents for those who can read. Customizing communications should lead to less noise around the message for the receiver as well.

To customize successfully, though, senders must understand the target population. Swanson (2008) has noted that customization and recognition of target populations often require decentralization in the country-led extension services. The design of a government agency shows the difficulty in identifying target populations. In this same keynote, Swanson provided multiple population targets for extension on the basis of gender, farm size, business level and diversification of crops, but those only start the list of issues that service providers could frame populations around. The point is that, for ICT to be truly effective, it must be grounded in a thorough analysis of needs and subsequent prioritization. Communication cannot be effective unless the sender knows the receiver and customizes the message content and delivery mechanism accordingly.

Knowledge transmission (communications)—Information, skills, training, education

As part of the communication process, the sender must identify the type of message to be sent. Is the message a one-time message, or does it involve a series of messages that lead to a greater understanding? It is critical to know whether the intent is to communicate information, skills, training or education. ICT interventions need to be designed for the specific type of communication. Toyama (2011) used Bloom's Taxonomy, which contains six levels of education goals for cognition -- from knowledge to comprehension, application, analysis, evaluation and synthesis — to advocate that knowledge, comprehension and application are the most critical for farmers. If extension agents are included as part of the communication system, the higher levels of Bloom's taxonomy are also important.

Information is generally perceived as data that provides critical but short messages. An example of information in extension functions would be market prices, weather reports or specific, short advisories -- e.g., on a pest outbreak. From simple information, the communication process moves into providing skills, training and education. Though all of these overlap, each level of communication is considered more complex. A sender can transmit more complex and nuanced information as the receiver acquires more skills, training or education. ICT can be used at all stages of the transmission process.

Extension agents rely on face-to-face communication to train farmers. Swanson (2008), Toyama (2011), Akers (2011) and FARA (2009) all state that extension practice needs reform, including new ways of offering services. Using ICTs to offer training and education for uneducated audiences is difficult to design but ICTs increase dissemination which is required if more smallholder farmers are to be successful. If EAS look to the developed world, ICTs have allowed for the unbundling of complex communications. In education, students can earn degrees online, but ICTs can also be used for dividing up courses into online and face-to-face. Several universities are already training extension agents online. In India, digital video that captures good practices is regularly used to train farmers alongside extension agents.

Global View of ICT Development — Access, Penetration and Networking through the Internet

Communication technologies involve people and telecommunications technologies including radio, television and the Internet. The media used can be the same technologies but may also include telephones (land and mobile), computers and smaller devices such as smart phones, which combine features of telephones and computers using the Internet. Increasingly, tablets, including iPads, are also becoming prevalent. The growth and ubiquity of the Internet lie at the heart of the ICT revolution in development.

The worldwide data on mobile phone and radio penetration are included in sections below (and also refer to Table 1). Radio and mobile telephones provide even more coverage and access than the Internet, but the Internet allows greater flexibility in types of communication, and it actually enhances what radio and mobiles can do as described earlier through the call-center example. Even Farm Radio International relies on the Internet and computers to keep a repository of its expertise. Growing Internet coverage in Africa and Asia is limited by the scarcity of electrical power. In the United States, it took 43 years for electricity to be available to 50 percent of the population, so Internet growth for providing EAS within Africa and South Asia clearly will be hindered by cost and infrastructure issues.

Though Internet penetration has eclipsed other technologies in North America and Europe, especially now that is it so connected to mobile telephones, the same factors do not exist everywhere. It is clear, however, that the Internet is a significant piece of the ICT puzzle. The Internet may not be the cheapest and most readily available technology, but including it among other technologies is almost required. For farmers, other significant barriers to Internet use include education level, language spoken, acceptability and dependability. There is no doubt that Internet penetration will continue to grow among farm communities. What is perhaps more important for EAS providers, funders, researchers and universities is to provide enterprise

mechanisms using the Internet that maximize all technology use. Essentially, the Internet remains the cornerstone because it can connect the more educated participants in EAS throughout the world so that these participants do a better job working with farmers.

Table 1. Internet continues to grow.

WORLD INTERNET USAGE AND POPULATION STATISTICS December 31, 2011						
World regions	**Population (2011 est.)**	**Internet users (Dec. 31, 2000)**	**Internet users (latest data)**	**Penetration (% population)**	**Growth (2000-2011)**	**Users % of table**
Africa	1,037,524,058	4,514,400	**139,875,242**	13.5 %	2,988.4 %	6.2 %
Asia	3,879,740,877	114,304,000	**1,016,799,076**	26.2 %	789.6 %	44.8 %
Europe	816,426,346	105,096,093	**500,723,686**	61.3 %	376.4 %	22.1 %
Middle East	216,258,843	3,284,800	**77,020,995**	35.6 %	2,244.8 %	3.4 %
North America	347,394,870	108,096,800	**273,067,546**	78.6 %	152.6 %	12 %
Latin America / Caribbean	597,283,165	18,068,919	**235,819,740**	39.5 %	1,205.1 %	10.4 %
Oceania / Australia	35,426,995	7,620,480	**23,927,457**	67.5 %	214.0 %	1.1 %
WORLD TOTAL	**6,930,055,154**	**360,985,492**	**2,267,233,742**	**32.7 %**	**528.1 %**	**100.0 %**

NOTES: (1) Internet usage and world population statistics are for Dec. 31, 2011. (2) CLICK on each world region name for detailed regional usage information. (3) Demographic (population) numbers are based on data from the U.S. Census Bureau and local census agencies. (4) Internet usage information comes from data published by Nielsen Online, by the International Telecommunications Union, by GfK, local regulators and other reliable sources. (5) For definitions, disclaimers and navigation help, please refer to the Site Surfing Guide. (6) Information in this site may be cited, giving due credit to www.internetworldstats.com. Copyright © 2001 - 2012, Miniwatts Marketing Group. All rights reserved worldwide.

Source: www.internetworldstats.com/stats.htm.

The global development of ICT for EAS relies on old, robust technologies, too. Radio has been used to communicate skills and training for decades at a low cost. Akers (2011) quantified the cost as less than 20 cents per search for price information on the basis of studies in Niger. The cost of mobiles was about the same. Radio has been recognized as an easy investment and one that can reach both women and men with low literacy. Farm Radio International has increased interactivity through call-in lines, multiple speakers, and training radio speakers on how to keep an audience engaged. Radio is still better at communicating information such as prices but has increasingly helped farmers with other important topics, including farming and business skills, and connecting communities.

Television typically costs more and is less dependable because of the lack of reliable electricity in rural areas. Television also suffers from lack of audience participation. The rapid adoption of mobile technologies has surpassed all other technologies except radio. (Mobile telephones will

be discussed later in the chapter.) Mobile technologies enable increased one-to-one communication with extension agents and other experts, and, when paired with the Internet as shown in examples later, can provide important communication for farmers, from prices, weather, and agriculture questions and answers to follow-up training with extension agents. The Internet still provides, even with the onset of smart mobile phones, more complex information and more audience interactivity. The current limitations of the Internet should not be considered a deterrent for planning better ICT services because it is clear from prevailing trends that penetration and accessibility of the Internet, even in rural areas, will improve rapidly.

Integrating Extension Functions into ICT

Designing an effective ICT strategy requires a thorough understanding of the functions of extension. According to Bell, Payne and Bohn (2011), the functions of extension are to: link farmers to markets; raise general awareness of opportunities; provide technical information, demonstrate or train; diagnose problems and recommend solutions; respond to follow-up questions raised by clients; provide mass advisories; facilitate access to credit and inputs; assist with business planning; and conduct surveys, monitoring and evaluation, and enumerations (refer to www.meas-extension.org/resources/ict). Those functions require different ICT strategies and options.

Table 2. Aligning extension functions to communication strategy.

Extension functions	Type of information	Frequency	Cost of repetition	Most available ICT	Strategy
Linking farmers to markets	Information and knowledge	Constant	Low	Mobile and radio	Integrated data and call center so that relevant agricultural information is readily available. Pricing information is available through automated call-in lines.
Raise general awareness of opportunities	Knowledge, training and education	Consistent	High	Mobile and radio	Requires blended approach in which Internet, call centers, mobile) and radio are combined to provide timely information
Provide technical information, demonstrate or train	Knowledge, training and education	Consistent	High	Mobile, radio, PDAs, tablet, video	Allows knowledgeable entity (NGO, extension office, private partner) to create both written and video information that can be delivered on demand through SMS, CDs or Internet connection from

Extension functions	Type of information	Frequency	Cost of repetition	Most available ICT	Strategy
					Personal Digital Assistant (PDA)/smart phone.
Diagnose problems and recommend a solution	Education	Consistent	Medium	Mobile, PDAs	Need database solutions that can be sent through multiple ICT channels such as call centers with both expert- and automated solutions.
Respond to follow-up questions raised by clients	Knowledge, training and education	On demand	High	Mobile	Requires agents to be equipped with customer contact tools but could also use a call center.
Provide mass advisories	Information	On demand	Medium	Radio	Requires integrated disaster and emergency planning technologies.
Facilitate access to credit and inputs	Knowledge, training and education	On demand	High	Mobile	Requires access to other networks, ways to help agents train through blended approaches.
Assist with business planning	Knowledge, training and education	Constant	High	Radio, mobile, PDA, Internet	Requires access to other networks, ways to help agents train through blended approaches.
Conduct surveys, enumerations, M&E	Education	Infrequent	High	Mobile, PDAs	Requires contact and database technologies.

Note: Personal digital assistants (PDA), tablet PCs and smart phones are generally used interchangeably, but a PDA or tablet may not always have telephone or Internet connection.

Broadcast and Voice-based Technologies

Broadcast technologies are very useful for extension strategies. Broadcast tools generally have limited audience participation, but many radio programs targeted to farmers often include questions and answers through call-in. Still, there is less audience participation than would occur with one-to-one mobile or even well-designed Internet training or DVD/CD training. Coupling broadcast tools with interaction can enhance the impact. Broadcast is aimed at serving large groups of people through radio, television or production of video. Digital video could be used today on site for small trainings through television, through video players and online, often through satellite feeds (on a monitor or projected on a screen). The online

dissemination is often very expensive and unsustainable. That is why many trainers who use video prepare for the likelihood of working offline.

Radio has reached high levels of market penetration. Television penetration has slowed. The number of inhabitants of less developed countries having radios and television has increased faster than the increase among inhabitants in more developed countries (Shackman, Liu and Wang, 2004, and UNESCO, http://stats.uis.unesco.org/unesco/tableviewer/document.aspx?-ReportId=143). This is not surprising because more developed countries are relying more and more on television and radio accessed through the Internet. Radio is recognized as far cheaper than television. Both radio and television require power, but radios can typically be battery-powered. Radio is simply more reliable than television in rural areas as a broadcast medium.

Radio and television are affected by government policy and political trends. If a country limits the number of radio and television stations or prefers to allow only media that are supported by the government, a lack of available channels that can carry extension-related communication will limit the potential impact. More developed countries with democratic governments have virtually unlimited numbers of radio and television stations, but the same is not true of most of the Feed the Future countries.

Radio remains a cost-effective ICT tool for extension

In 2008 and 2009, Farm Radio International launched several participatory radio campaigns (PRCs). A PRC is defined as:

> *"A planned, radio-based activity, conducted over a **specific period of time**, in which a broad population of farmers is encouraged to make an **informed decision** about adopting a specific improvement selected by their peers, based upon the best available information, to improve the food security of their families. It then provides the adopting farmers with the information and other support they require to implement the improvement"* (Yordy, 2008).

These PRCs focused on five countries in Africa: Ghana, Malawi, Mali, Tanzania and Uganda. The PRCs were deliberately set up to test their impact on farmer productivity. The results are quite positive, as the chart below shows. In the identified active listening community, Farm Radio International collaborated with communities to engage listening groups in discussion as well as transmit knowledge. The surveys detail that 82 percent were listening, 70 percent demonstrated knowledge and 39 percent (in two years) started the practices that were introduced during the PRCs (Figure 2)

Yordy (2008) and Farm Radio International both report on how radio has become more interactive as a medium without becoming significantly more expensive. Using call-in features, texting (Simple Messaging Systems, SMS) responses and multiple speakers, lively discussion and trained radio speakers, radio can be made very engaging for the audiences. It is worth noting that almost all of the participating survey respondents indicate that programs are started with external funds. The costs are low to maintain but typically require advertising or ongoing grants. The long-term cost is not an issue unique to radio but bears mentioning because extension organizations need continual communication with farmers, and thus secured long-term funding sources, to be highly effective. ICT new and current projects should be required to establish a business plan for sustainability once the initial external funds are spent.

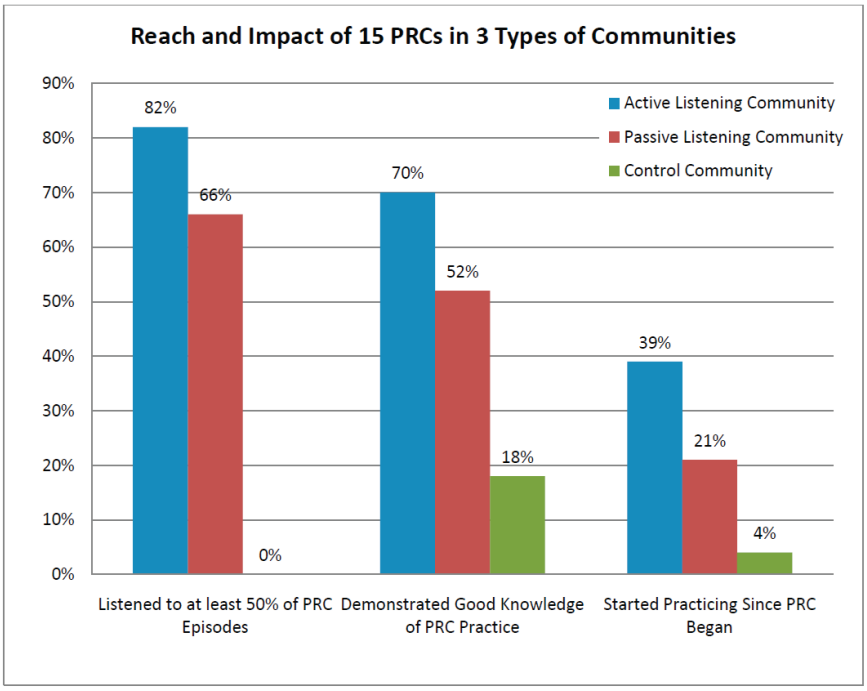

Figure 2. Effectiveness of participatory radio campaigns, PRCs (Yordy, 2008).

Video Enters the Age of Low Cost and Interaction

Video is a one-way broadcast medium. Television is the most widespread medium in the developing world for video, but television is rarely used for farmers or by extension in the developing world. Cost of TV sets, too few television stations and little availability in rural areas mean that television has less impact than it does elsewhere, including in urban areas of developing countries. Videos can now be developed using fairly low-cost tools, and hand-held devices with fair quality are widely available1. Frequently, videos are used on the Internet to support learning. Digital Green, www.digitalgreen.org, is the most successful video production and training organization dedicated to farmers. The projects have been focused on 900 villages in India, but Digital Green is moving to other less developed countries as well. The website currently states that Digital Green has produced 2,511 videos, which have been viewed in the field 107,210 times. Women are credited with 25 percent of the videos produced but constitute 75 percent of the watchers. The website uses the following description:

> *"The Digital Green system combines technology and social organization to improve the cost-effectiveness and broaden the community participation of existing agricultural extension systems. The unique components of the Digital Green system include (1) a participatory process for local video production, (2) a human-mediated instruction model for video dissemination and training, (3) a hardware and software technology platform for exchanging data in areas with limited*

[1] USAID/FACET: Integrating Low-Cost Video into Agricultural Development Projects: A Toolkit for Practitioners. Available at http://ictforag.org/video.

Internet and electrical grid connectivity, and (4) an iterative model to progressively better address the needs and interests of the community with analytical tools and interactive phone-based feedback channels."

This model is complex and expensive but has been shown within India to promote substantial improvement in farm income and lives. Digital Green does work with EAS, and EAS has been recognized as a very important part of India's transition from a net importer of food to a net exporter. In its 2010 annual report, Digital Green reports its model integrated with their existing extension operations had a cost per adoption $3 to $4 and improvement of 45 times each dollar spent. During its first eight months, the average cumulative increase in incomes was $242. According to its analysis, 130,967 adoptions of new practices have been made. Currently, impact assessments are limited to those that the organization has done but Digital Green is working with researchers from Innovations for Poverty Action, Yale University and the University of California, Berkeley, using multi-intervention, randomized controlled trial methods.

Like Digital Green, most organizations use video so that it can be stored and shared. Unlike most other users, Digital Green has systematized, integrated and computerized its processes to ensure reuse. The success of Digital Green also lies with the communication and use of local people, including extension agents. Involving local people in production means that farmers are active and learn from one another. Involving extension agents and other trained agriculturists means that good practices are taught and disseminated. Broadcast media in extension need to take this sort of highly interactive approach to communications.

Leading with Mobile Devices Spurs Extension Strategies

The era of mobile telecommunications has arrived. According to the World Bank, there are more than 5.96 billion mobile subscriptions (Table 3). In many continents, mobile technology has the highest penetration of all ICTs. In the poorest of nations and Africa as a continent, the impact is growing, though it lags in the rural and farming communities. The four countries with the largest subscriber base in Africa are Nigeria, South Africa, Kenya and Ghana (Rao, 2011). The Middle East and Africa will have the strongest mobile data traffic growth of any region at 129 percent compound annual growth rate in the next couple of years. The reliability in rural areas where most farming takes place is not as robust, and the cost for rural families is often very high.

Table 3. Telecommunications penetration throughout the world - Key global telecom indicators for the world telecommunication service sector in 2011

	Global	Developed nations	Developing nations	Africa
Mobile cellular subscriptions (millions)	5,981	1,461	4,520	433
Per 100 people	86.7%	117.8%	78.8%	53.0%
Fixed telephone lines (millions)	1,159	494	665	12
Per 100 people	16.6%	39.8%	11.6%	1.4%
Active mobile broadband subscriptions (millions)	1,186	701	484	31
Per 100 people	17.0%	56.5%	8.5%	3.8%
Fixed broadband subscriptions (millions)	591	319	272	1
Per 100 people	8.5%	25.7%	4.8%	0.2%

Source: International Telecommunication Union (November 2011). All figures are estimates.

Using Mobile Telephones: From Automated Response to Promoting Networking

Though excitement is building about the potential of mobile phones and smart phones using wireless and broadband throughout rural regions of Africa and Asia, issues of literacy still remain (Asingwire & Okello, 2011). The ICT framework needs to be carefully considered when planning for mobile phone use. Two case studies in Uganda indicate that it is important to consider the benefits from simple tools such as mobile phones in light of other barriers such as infrastructure, electricity, level of poverty, level of literacy, type of information to be transferred and sustainability (Donner, 2009)]. If a project is trying to change behavior, such as farming practices, then simple mobile technologies might be too limited. Where information can be pushed to farmers – such as market information services, weather reporting and follow-up contacts -- mobile devices work well. These mobile tools can improve the frequency of messages, but, like the voice and broadcast technologies, if they are not integrated into a systematized response mobile responses alone won't improve farmer knowledge.

Mobile calls and simple messaging systems (SMS) connect people and information

The mobile revolution has challenged extension to align functions and services with appropriate ICT tools. Mobile phones can be used by farmers, members of the community and extension workers to connect and communicate. Donner (2009) shares a number of services that use mobile phones for interaction with rural farmers. Providing market information is the most frequently offered service. This aligns with cell phone's limited ability to convey information (Donner, 2009) . All of the projects also provide more options to connect to services. Before mobile technologies, connecting to rural farms and providing information was time-consuming and involved hours of travel. The information provided can give farmers a critical resource.

The World Bank ICT in Agriculture Sourcebook offers examples from several projects in which extension agents and farmers use mobile phones to extend their communications (Table 4). Most of these projects are not limited to mobile applications and are tied to Internet-based applications. Still, the impact from mobile on extension functions deserves attention. The table below lists and describes various projects. Most of the projects can be grouped as linking farmers to markets, and most of them include extension. The extension roles vary by project. In

some cases, extension finds the sources of information and helps create the mechanism for communication; in other projects, extension is one of the partners.

Table 4. Mobile applications in agriculture.

Project	Description and mobile use	Extension function
Kenya Agricultural Commodities Exchange	Use Safaricom SMS platform to link farmers to buyers	Link farmers to markets
Uluguru Mountains, Tanzania	Mobile access by women farmers to current market information	Link farmers to markets
Uganda Rural Information Systems	Mobile updates for rural farmers connected to a full ICT and experts who train the farmers	Link farmers to markets; raise awareness, provide information, demonstrate
mFarmer (India, Kenya, Ghana, Ethiopia, Uganda, Nigeria, Mali, Rwanda, Tanzania, Malawi and Zambia)	Mobile access to advisory services	Provide technical information, demonstrate or train; diagnose problems; recommend solutions; respond to questions
Xam Marse, Senegal	Mobile information including prices and availability of fruits, vegetables, meat and poultry	Link farmers to markets
Eastern Corridor Agriculture Market Information Centre, Ghana	Market information to community cooperatives	Link farmers to markets
InfoPrix, Benin	Market information, staple foods	Link farmers to markets
Esoko, West Africa	Market information	Link farmer to markets
Kilimo Salama, Kenya	Provide insurance to farmers through a unique mobile purchasing system for seeds, fertilizers and pesticides	Link farmers to markets; facilitate access to credit and inputs
M-farm, Kenya	Link markets to farmers, allowing bulk purchasing	Link farmers to markets

Source: World Bank, 2011.

The most sustainable approaches are the Kilimo Salama and M-farm because their approach is to involve for-profit companies, which can make money in the transaction, and lower the overall costs through economies of scale (World Bank, 2011). In Kilimo Salama, the prices are paid to the Internet service intermediary. Farmers pay a 5 percent increase on inputs such as seeds and fertilizers for insurance, and the farmers get compensated from the insurance fund if there is severe weather and their crops don't grow. Kilimo Salama pays automatically on the basis of input from weather stations. M-farm connects farmers to insurance for seeds,

fertilizers and pesticides. These two projects are also housed in Kenya, where the telecommunications policy environment is favorable. Many telecommunications innovations have sprung from Kenya because it offers a business environment that spurs innovation in telecommunications.

Extension services could leverage mobile projects for many activities. The pilots and projects listed above were funded by outside grants and public/private partnerships. Setting up pilot projects using innovative technology requires flexibility and a willingness to partner with outsiders as experts. Pushing information to farmers, creating opportunities for public/private partnerships where private partners make money, and making technical and advisory services available through SMS and texting could be supported by EAS. The bigger challenge for EAS is to become a pluralistic and innovative system (Swanson, 2008; Toyama, 2011).

A more complex endeavor is mFarmer. The vision of the mFarmer Initiative was to spur members of GSMA, an association of 800 mobile operators serving over 95 percent of the market in developing countries, to adopt new approaches to provide value-added agriculture information to farmers in developing countries. In 2009, the Bill and Melinda Gates Foundation (BMGF) made a grant to GSMA to catalyze mobile operators' investment in these innovative mobile services, evaluate their impact, and facilitate experimentation with sustainable and scalable delivery models. USAID also provided expertise and grant funding, which provided pilot funds to mobile operators with innovative approaches. According to USAID web pages, one model in India has been proven to have an effective and sustainable approach, showing a demand by close to 1 million poor farmers in the first year.

The global mFarmer Initiative includes the development of a global, shared database of digital agricultural information, a challenge fund to promote innovative partnerships between operators and public or private agriculture extension service providers, technical assistance, sharing of best practices and impact evaluation. It spans 10 countries in Africa and India. The technology setup is very complex and fully integrated -- mobile responses are connected to a call center into a database. This means a mobile question is answered with a mobile response while an employee or extension agent might be called or sent information to provide an expert response. The integration of mobile, computing and databases allows for a sophisticated response system. GSMA has opened a mAgri initiative in part because of this work. The difference is that mAgri provides the business case for investing in agricultural value-added services (Agri VAS). Mobile operators now understand that launching products for agriculture should provide enough economic gains for farmers to more than pay for using the mobile service. As promising as these initiatives appear for the very poor, rural farmers, however, the investment in mobile technology will lag behind the current adoption curve.

Part of the lag is that mobile access for women is much lower than that for men. The data published in a study entitled "Women and Mobile: A Global Opportunity" shows there is a gender gap in mobile phone ownership and subscriptions -- 300 million fewer women than men own cell phones. For EAS, these figures mean it is more difficult to use this low-cost ICT to serve women. Though some data show that women prefer voice over SMS, the fact that fewer women own mobiles means that it is probably too early to determine whether women's

preferences are not being met. The study and the one by Rao (2011) both make it clear that these factors will change in the coming years.

The mFarmer model is unique but expensive. It also leads directly to some of the more sophisticated Internet-based tools used in the developed world, such as eXtension in the United States, set up by the Cooperative Extension System and the U.S. Department of Agriculture. In eXtension, information is contributed by communities of practice in all 50 states and provided free to the public. Note that the funding model for eXtension is based on ongoing government contributions. So unless the models of funding can be shifted so the investment in mobile technologies is either a government expense or, as in Kilimo Salama, the higher pricing buys service and insurance, it is difficult to see how to sustain the provision of these modern ICT tools.

Facilitating Access to Credit and Business Planning Through Mobile Phones

Financial transactions in and of themselves are not extension, but facilitating access to credit and inputs can be seen as an extension function. Furthermore, access to banking services may be a prerequisite for farmers to implement recommendations made by extension. Other exciting mobile projects include those that facilitate access to money, credit and sales through SMS. In Africa, these services again originate from Kenya, which has revolutionized how cell phones are used (World Bank, 2011]. M-PESA, a mobile application set up by Safaricom, allows users to transfer money using mobile phones without having a bank account. In Kenya, the banking process, as in many other African countries, is time-consuming, and access to credit is limited for all but the wealthiest. Banking for businesses is also a time-consuming process. M-PESA did not start as a tool for farmers, but it is now being leveraged by farmers to pay bills, to buy necessary items and to pay for services.

In the World Bank ICT in Agriculture Sourcebook, and in Pakistan, India and Bolivia, mobile banking and thus access to money from your mobile is being used to serve rural areas, including farmers. These other projects are also leveraging microfinance funding. In microfinance, rural farmers and often small entrepreneurs are given loans or credit to make investments that are designed to make the farmer self-sufficient or to pay back credit with a very low interest rate over time. The sustainability of such efforts is clear with examples such as the Green Bank in Malawi, which calculated that, through savings from mobile technology using text-based collection methods, they were able to reduce interest rates and services charges while increasing profits (Kumar, McKay and Rotman, 2010). All of these mobile money applications have cut time and costs, expanded services, and connected buyers and sellers, and make enough money to stay in business. For EAS to use mobile transactions, governments will need to coordinate financial and agriculture policies.

Internet and Computing Change the Information Flow

The personal computer and constant growth in computing power have improved productivity and led to huge economic growth in developed countries. The world of ICT applications has been fundamentally changed by the age of the Internet by making it easier to find information and to communicate with others. These two tools, computers and the Internet, have powered

new ways of training and learning, and emergent approaches to development. Widespread use of computers and the Internet is not yet a reality in all developing countries, as shown in Table 1. The availability of the Internet and cost of personal computers limits what extension can currently do to benefit target groups such as farmers. Though it is difficult to forecast, it is likely that the trends of increasing availability and use of these tools will continue. It also seems likely that computers will get smaller and less costly and become more available as smart devices such as smart phones and tablets (iPad and others).

The rise of these tools requires that extension-related projects plan for them. The number of at least initially successful projects is numerous. Ross and Bohn compiled an inventory of ICT applications in agricultural development used in India. The MEAS project continually updates this and has identified 200 initiatives (Ross and Bohn, 2012). These projects focus around all extension functions. The ones that focus on the Internet seem to include those from single websites to those that include databases and those that rely on repositories. Single-page Internet sites provide links and can provide highly useful information. Many agriculture websites now rely on some type of database running in the background, which allows users to search using either a search tool or navigation. The more recent generation of agricultural websites relies on open source tools. Open source technologies are freely licensed, and typically a group of software programmers who use the tools continually update them. Open source is a good choice for the extension community because it lowers the cost of ongoing ownership and thus increases sustainability.

Knowledge management adds sustainability to information

One well-developed database-driven tool is Africa Crop Calendar by the Food and Agriculture Organization (FAO, www.fao.org/agriculture/seed/cropcalendar/welcome.do). The crop calendar is accessible to individuals and extension workers. FAO describes the crop calendar as:

> *..." A tool that provides timely information about seeds to promote local crop production. It contains information on planting, sowing and harvesting periods of locally adapted crops in specific agro-ecological zones."*

When a knowledge management system is built, the capacity to serve additional audiences should be planned for the future. If a project is built to serve extension workers who have Internet access, the plan for the future would be to allow farmers to access the same information. Farmers can add to knowledge management websites by providing firsthand information. However, it is often difficult to move from a hierarchical system where only experts such as researchers and universities contribute EAS content to one where practitioners and experts can use the same set of tools. As can be seen in the developing world, anyone can post information to the Internet in a myriad of ways—blogs, websites, wikis, etc. The point is not the ICT method but the control of information. Though rural poor farmers may not post, extension agents can provide recommendations, as can NGOs, private citizens and even private companies. The recommendation to those building knowledge management tools is to build a flat architecture that allows multiple EAS providers and clients to use the tool simultaneously. This is good planning, even though many farmers don't have regular Internet access yet.

Another useful example falls under the extension functions of raising awareness and providing technical information. Collecting and Exchanging Local Agriculture Content (CELAC), www.celac.or.ug, located in Uganda, offers learners multiple resources via multiple methods. These training resources offer extension professionals and farmers great information without charging fees. There are numerous examples that utilize e-learning. E-learning can be done with Web-based software, learning management systems, video and simulations. Often the least expensive model is a course that allows self-paced studying of mainly text-based material. The limitations are that not many farmers and not many extension staff members have consistent and reliable Internet access. However, extension agents and other community intermediaries who do have reliable Internet access can then pass on their learning through other means. The Digital Green approach mentioned earlier is an example -- trainers engage the community but must use offline technologies when training in a village.

The ICT spreadsheet mentioned earlier shows 38 of just over 200 examples that are related to education. The tools used are mostly Web-based and asynchronous -- learners can access materials at a time and a place that are convenient to them. A few examples include synchronous tools such as Web conferencing, from simple Skype to the more complicated Web conferencing software that provides for voice, data, presentation and screen sharing capabilities. Many development agencies and donors host webinars to engage stakeholders in learning about agricultural development (e.g., Agrilinks, http://agrilinks.kdid.org).

Open education resources (OER) are another effort to make copyright and reuse of resources easier. The concept of OER was set up well over a decade ago, and by now millions of OER are available openly. For education, this is huge opportunity to reuse content that is created by others. The content is then customized for local learning needs and combined with a delivery strategy designed to improve learning through use of demonstration, training, hands-on experience, etc. AgShare is a project of Michigan State University and OER Africa, www.oerafrica.org/agshare/AgShareHome/tabid/1290/Default.aspx, along with four partner universities]. In two universities, USIU and Haramaya, researchers and students worked directly with extension agents to visit farm communities and develop both community-based materials and materials for universities.

The repurposing of materials is done routinely; the advantages include involving graduate students in community-based research. This research is then available for other universities and extension agents to disseminate. Using a student to help document and solve community agriculture problems offers human capacity to serve the millions of underserved farmers. The collaboration among extension, universities, students and communities leads to improved production processes and prepares students to participate in modernizing agriculture.

Digital Green is built on participatory principles, promotes farmer-to-farmer learning and acknowledges the fact that innovation can very well originate in rural communities. Many of the videos are designed to share farmers' best practices. In cases where improvements or guidance is needed, both extension and Digital Green help villages with new solutions and techniques. But the farmers tell the story, and these stories are openly available on Digital Green's website and on YouTube.

Extension functions such as facilitating access to credit and inputs and assisting with business planning are critical but often are last on field workers' lists. Field workers are already overburdened with providing production advice; assisting smallholders in the transition from net buyers to self-sufficiency to net sellers requires the teaching of business skills. A website that serves these functions is called Linking Learners, www.linkinglearners.net . It offers members extended services.

> *"This internet service supports local entrepreneurs in Africa in learning how to operate commercial market access enterprises. These enterprises link small farmers with other key players in the market chain from producer to consumer in Fair Trade for all* (www.linkinglearners.net)*."*

Providing business knowledge is always context-sensitive, but best practices and great ideas can be easily exchanged via a website. The difficulty arises when extension agents try to scaffold the information. In education, instructional scaffolding is the process of moving the learner from one level of understanding to another, deeper level of understanding. Both education and training use scaffolding to improve instruction. For example, when moving a smallholder from self-sufficient to net seller, it is likely that a full business plan and strategy would be overkill. Instead, these farmers are looking for very specific information that is focused on solving the task at hand. When what is needed is a specific step-by-step plan, overloading farmers with non-essential information often provides too many choices.

The next type of service is knowledge management. The knowledge management websites often collect multiple types of information and sort it in a way that makes it searchable. Many of these knowledge management tools begin to pull resources from other websites. Knowledge management is both a repository and a database. As a repository, it often stores extensive information. The newer knowledge management websites also pull information from other websites through Real Simple Syndication (RSS) feeds or harvest data through the use of "crawlers" designed to look for certain materials.

Database applications are not new. These show up in many of the projects listed in Table 4. Generally, databases are behind-the-scenes support of ICT, but it is critical that these are brought to the forefront and made more widely accessible. The raw data is unlikely to be of use to farmers, but it is of great use to EAS – researchers, universities and extension agents can query the databases for information. The databases are likely to be built by very large organizations such as the World Bank, the Food and Agriculture Organization (FAO) and governments. The World Bank and FAO both announced an open access policy, which promotes both open data and open resources. The rationale is that the more open data is, the more it can be used in ways the organization did not plan. ICT planned for tomorrow should be built to serve as many as possible within EAS. A flexible design is achieved through building relational databases. A relational database is a database with many tables of information where the tables are related through key information. Organizing content in relational databases and facilitating flexible searches of content enables extension to use information in multiple methods. The improvement in search is based on better meta-data and semantics that accurately describe the content. Search algorithms make it possible for prescribed information to be sent automatically or customized information, as long as one has access to the database.

These resources will be explored as they are by many throughout the EAS system, but it is more likely that the move to make databases open and searchable will improve content written for extension agents and farmers.

Databases created for new projects should not just rely on information they hold. In the world of connected repositories, it is possible to send project information to internal and external databases. The same is true at a project level -- databases can pull in information from other open databases. Given the amount of information available through government, NGOs, international funders and others, the opportunity for projects in the future to pull data rather than recreate it is considerable. Linked databases can work the same way as the open educational resources mentioned earlier that allow immediate reuse and revision (by language or adaptation).

Ferris (2011) describes the more advanced approach in Figure 3 below. The proposed diagram includes an enterprise or large organization's systematic approach to creating a unified information platform. An enterprise solution is one that integrates the job functions of people who are part of the organization with their business roles to provide rich information that speeds productivity. Catholic Relief Services (CRS) is sharing its way of planning for multiple stakeholders, including extension, to receive information that will be drawn from third-party databases and portals. The implication is that, at each step in the process of creating and using information, the organization will have the ICT tools that record and capture the information. That recording process can create efficiencies, reduce mistakes and improve productivity. Granted, not every project has enough funds to plan at an enterprise level, but lessons of how to integrate ICT into every stage of development can be drawn from reviewing enterprise planning. The concept combines the communication process and needs with intended users, project managers, available ICT tools and communication flow. The documentation provides more clarity on how the big picture should work for extension. Any enterprise ICT plan includes drawing on databases from third parties, pulling in and sharing data externally. CRS then organizes its portals, a combination of websites and databases, into an enterprise repository. This repository services internal staff members, field agents and beneficiaries.

The design offers an integrated approach and one intended to share information beyond one unique audience. Serving a unique audience and special need might be part of a project, but ICT should be integrated to make tools easy to use and to make sure information can become part of the lasting knowledge base that serves extension efforts. The USAID ICT for Ag website, https://communities.usaidallnet.gov/ictforag/home, and the World Bank and Agriculture in Rural Development, http://tinyurl.com/dyjpbbm, all describe the importance of integrated ICT approaches.

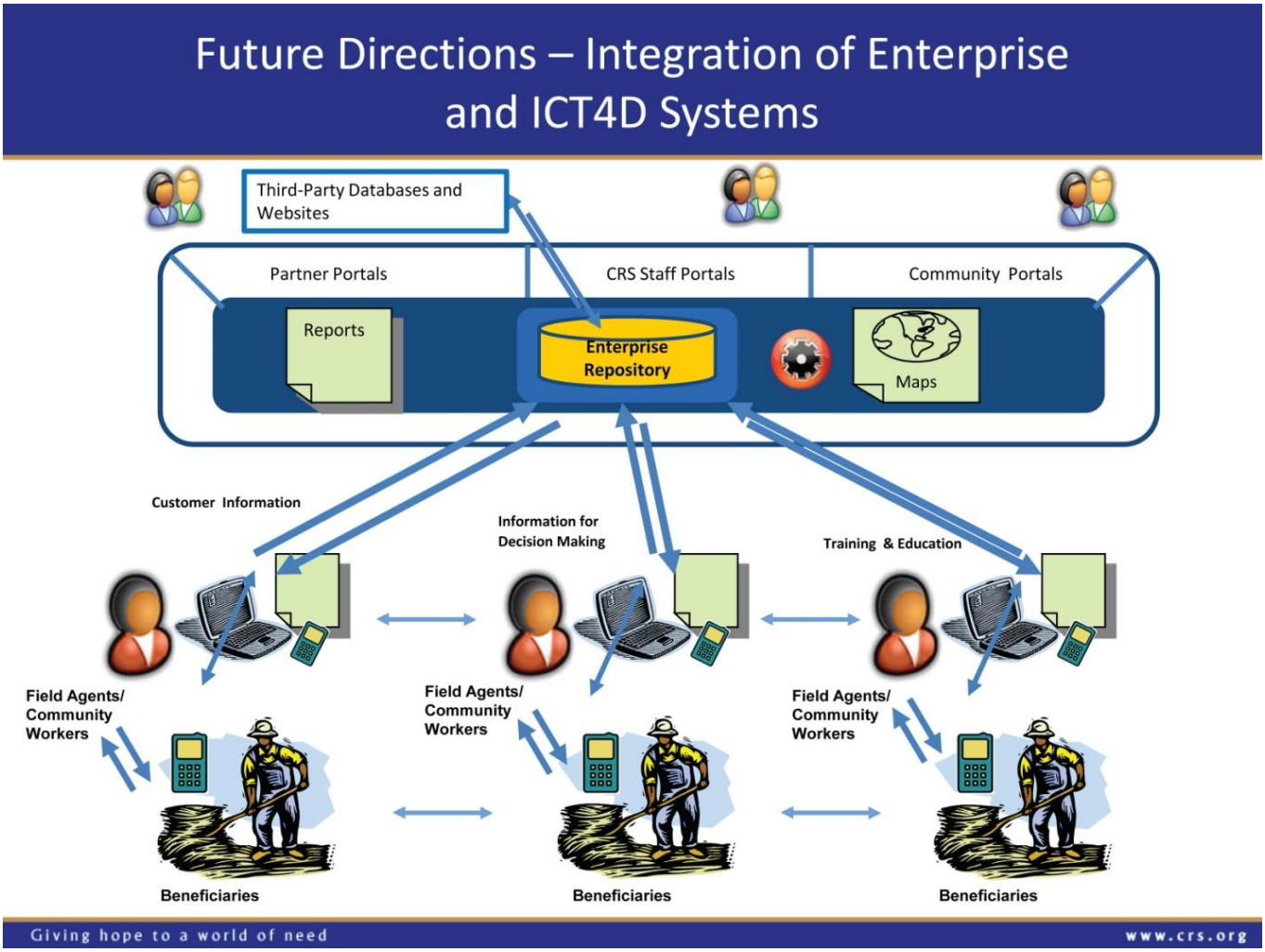

Figure 3. Knowledge management portal serving extension service providers and farmers. Source: Ferris, 2011.

Social Media Evolution — the Power of Networking

Social media are Internet-based tools that enhance the ability of a group of people to discuss and network. Extension agents have been networking with farmers, cooperatives, communities, NGOs and government agencies since extension was created. Extension agents represent a human broadcast medium, and social media allow many voices to engage in the discussion. The power of that kind of networking is that it can move through a community very fast. The challenge is making sure that the messages are accurate and truly useful to the community. In the United States, eXtension has built an infrastructure that allows for communities of practices (CoPs) to share knowledge and information. These CoPs allow like-minded people from all over the United States to work together. Through social media, including blogs and questions from participants, eXtension is reaching out online to build a 21st century extension service for the United States (www.extension.org).

The Worldwide Extension Network, http://groups.google.com/group/worldwide-extension-network?pli=1, is an example of a blog through Google Groups that is used by people with a

professional interest in extension. On Facebook, various profiles have been set up by agricultural development organizations, interest groups, implementing agents and networks, including the Worldwide Extension Network, to promote networking and information sharing.

Current ICT infrastructure means that, for the short foreseeable future, most social media in extension will likely be used by those at a training or policy level and not by clients, although there are examples of producers trying to sell their wares through Facebook and Google. EAS should include a social media plan because highly successful social media campaigns enhance communities through networking people and information. Given the conditions in many rural areas, connecting farmers and their families to EAS could advance needed knowledge exchange.

Integration and Design Strategies for ICT-Supported Extension

All ICT project deliverables must start with some simple steps. In each case, EAS must constantly assess the situational needs of its users. When designing a deliverable, three key questions should first be answered: what is the problem or need, what is the real-world performance that is expected, and what are the terminal (long-term) objectives? These three factors plus the context inform the message or communication. Will the message be simple information, knowledge, training or education? After the type of knowledge is determined, the next step is to analyze available technology tools. The analysis needs to include all users, from clients (farmers) to agents to organizations.

The content or communication must then be structured. Will there be prerequisites, such as prior knowledge? How will the content be organized? Will the content deepen understanding for the participant? “Scaffolding,” an instructional design term, has to do with creating information that the learner can build on. Once the foundation is built, then more information is provided. There is considerable evidence that this is an important approach when working with illiterate and less educated clients, but scaffolding is applied in college-level online learning as well.

Will the information be available in a linear or non-linear fashion? In linear learning, experts design the steps and expect learners to follow them. In the highly networked and information-rich world of today, communication and information are increasingly non-linear. In this less controlled environment, the communication process would be surrounded by noise (Fig. 1). The noise could be useful or distracting, but it is still noise. So when designing in the ICT environment, projects must move beyond a simple linear design. Integrating complex non-linear approaches are useful because it assumes the learner has both other networks that inform him/her and the learner may be a source of information as well.

The next design step involves the method of delivery -- how the learner or farmer should be taught. For example, should it be knowledge recall, does it need practice, should it be interactive, or should the method be applied? The choice of method affects the choice of technology. So if the method is direct, a simple broadcast tool might be cheap and highly effective. If the method requires interactivity, a combination of Web-based tools by which learners are actively participating could be useful. This is an approach used in e-learning,

simulations and games. Interactive approaches could also mean designing an environment that uses ICT in combination with face-to-face experiences. Combining face-to-face with Web-based learning is typically referred to as blended or hybrid learning.

Once the method is decided on, an appropriate monitoring and evaluation (M&E) scheme should be put in place. Also plan what to do with the M&E outcomes. Do the results need to be stored, sent to others or used for research, or are they simply a tool for the learner? All these characteristics inform the design of the ICT environment.

Another approach modeled by Woodard (2011) is shown in Table 5. The approach here is to consider context and ask framing and planning questions. The questions are thoughtful and provide designers with insight. This tool is also very easy to use in groups that don't have much design background. Bringing all stakeholders to the decision and planning framework helps promote buy-in for the project. It also provides the technology designers with information about clients that they are unlikely to know.

Table 5. Decision-making and planning framework.

1. Why? Desired consequences; immediate, midterm and long-term outcomes and results	**2. Context?** Situation and challenges; barriers to overcome, and assets and opportunities	**3. Beliefs?** Core principles governing our decisions and actions; non-negotiable	**4. What, how and who?** Essential actors, core components and critical structural elements	**5. Are we there yet?** I
• What changes do we want to have happen by the time the project is over? • Immediate changes/results? • Midterm changes/results? • Long-term changes/results?	• Characteristics of the situation in which we work? Barriers to overcome? • Characteristics of the target audience that we seek to help? • ICT assets already present in the communities we will work with? • Future ICT expectations? • Opportunities that exist within the environment and system that we can leverage?	• What development principles and non-negotiable elements do we have to consider in how we implement our approach?	• Given our response to sections 1-3, what approach will we take to best achieve our desired consequences? • How will it be implemented? • Who will be responsible for implementing this?	• Indicators • Measures of success • Assessment methods

Source: Woodard (2011).

The design of ICT is quite challenging, and as Woodard (2011) details, it must consider at least five design characteristics, which he phrased as questions. The design phase is, of course, only an initial step. After conceptual designs are in place, then the early technology design -- such as wireframes, which include software and hardware specifications -- must start. Too often technology designs are delegated solely to Web designers and programmers. The information technology professionals must work side by side with a range of stakeholders, however, including the end users. Important IT development issues should challenge the team as the project is created. Often new IT projects are created from scratch without knowledge of how ICT is being used in the industry. To make a project sustainable, an ICT should consider low-cost and community-based open source tools. Open source designs provide any project with a team of developers and demonstrated success of launched projects. For the best-fit practice for ICT development in EAS to have impact, project implementations must include working with end users, whether those are farmers or extension agents.

The IT team also needs to make plans to make the information sustainable. For example, can the information be shared with other websites or repositories in case project staffing or funding is lost? Having a sustainable project plan requires the IT team to understand enterprise design and find similar approaches used in other projects. It is always important to improve upon projects, but typically the effort in IT development is more about designing from scratch. Designing from scratch is expensive, and it may not incorporate best practices. The IT team must understand best practices well enough to share them with the project team.

ICT for Extension Has Growing Importance

Extension remains a valued service throughout the world. Like many other organizations that train and educate people, Extension is increasingly being asked to do more with less. Most of those other organizations are responding to those challenges by extending the reach of information through ICT. ICT is both complicated and simple. The simplicity is that at the center is the communications process as shown in Table 1. The complexity is found in addressing the type of information with the appropriate set of tools to deliver that information. The complexity also derives from ICT maturing as an industry. With maturity comes a need to design integrated and enterprise platforms for sustainability. The future of ICT extension must include projects sharing resources and design. Agriculture information repositories are becoming part of the landscape. ICT for extension needs to integrate into a continuing flow of information using strategic design and best practices.

All projects will vary in scope and design. ICT will continue to evolve and improve. The capabilities of tools and the availability of technology to clients will continue to change. Table 6 summarizes the extension functions, level of information required, field agent constraints, best tools, databases and software, and enterprise resource planning and repository requirements in the current environment. Table 6 is built on the work of Judith Payne and Mark Bell and is not intended to address all possibilities but to summarize the use of ICT in EAS. The table is meant to help non-IT personnel understand the choices that exist by function.

Table 6. ICT options in relation to extension functions.

Extension function	Level of information required	Field agent constraints	ICT -- which tools are best?[2]	Databases and software	Enterprise resource planning and repository requirements
Link farmers to markets	Information and knowledge	Not reliable	Radio, texting, smart devices	Should be tied to an official commodities exchange or other pricing mechanism	Need to integrate into countrywide strategies
Raise general awareness of opportunities	Knowledge, training and education	Not scalable	Radio, smart devices, computers, Web	Databases should pull from useful websites	Repositories are key to sharing information widely.
Provide technical information; demonstrate or train	Knowledge, training and education	Effective but not scalable	Radio, TV, video, computers, Web	Simulation and training software should be explored	Information should be stored so it can be repurposed
Diagnose problems and recommend a solution	Education	Effective but not scalable	Mobile, smart devices, computers, Web, social media	Databases should pull from similar problems	Repositories should be investigated
Respond to follow-up questions raised by clients	Knowledge, training and education	Effective and personal intervention necessary	Mobile, computers, Web, social media	Call center database needed	Enterprise integration of information is necessary.
Provide mass advisories	Information	Not reliable	Radio, broadcast media, texting	Emergency response software	Tracking software
Facilitate access to credit and inputs	Knowledge, training and education	Effective but not scalable	Radio, video, computers, Web, social media	Databases connecting buyers and sellers	Tie to repositories on subject
Assist with business planning	Knowledge, training and education	Effective but not scalable	Radio, video, computers, Web, social media	Database connecting information business planning	Tie to repositories on subject
Conduct surveys, M & E, enumerations	Education	Excellent	Mobile, computers	Survey tools	Enterprise feedback is needed.

Source: Derived from Mark Bell and Judith Payne (2011). Original found at www.meas-extension.org/resources/ict.

[2] Radio, multimedia broadcast (TV, video), basic mobile phones, text, voice, small smart devices, computers, Web, social media.

Summary

Best fit for ICT in extension and advisory services is difficult to summarize because the system has so many participants -- from farmers to extension agents to universities and researchers to NGOs to governments to worldwide organizations. Each player within the system requires different ICT options, and EAS lacks the funds to provide those tools in a systematic way. So this summary is more of a guide to the usefulness of ICT tools for the various participants.

For farmers, including women, the most obvious tools are mobile telephones that incorporate the SMS and voice options. The number of mobile subscriptions will continue to grow significantly throughout the rest of the decade. Though many very poor and rural farmers will lag behind others in adoption, they will begin to adopt mobile. EAS should learn from the numerous pilot projects, especially in the ICT in Agriculture Sourcebook, what would be the most effective mobile applications for farmers. So far, those seem to be information pushed to farmers along with call center question -and-answer services. Those services, however, require integration of databases, call centers and sophisticated mobile network operators using systems set up for projects such as mFarmer.

Extension agents both inform farmers and need constant retooling as new information is available. Making use of mobile ICTs may be as impactful for agents as it is for farmers. When new and important information needs to be sent through the system, governments must build mobile tools that will alert agents to this new information. The agents will also need to use new Internet-based tools such as e-learning to expand their training options. Training and education for agents should use e-learning combined with field-based practice. This blended learning approach will lessen the time that an agent will need to be out of the office and still provide him or her with updated knowledge and techniques.

For those researchers and universities involved in EAS, e-learning ICTs become paramount for training extension agents and government officials. An example of e-learning design is the way African Virtual University works with its partner institutions. The approach is to mutually decide content for a degree, share design of curriculum and courses, and then use well-designed e-learning to reach those objectives. The outcome would be a current and agreed upon curriculum to train extension agents and others. Researchers and universities must also adopt more open policies using both open educational resources and open data.

These Internet tools will disseminate information and research results faster than the current methods where curriculum and resources of a university are hidden from the public.

NGOs, governments, worldwide organizations and funders must set both micro and enterprise ICT standards. For pilot projects, these influencing organizations must set evaluation criteria and technology specifications. For an ICT pilot to be useful, it should build on the findings from previous related pilots. Pilots should be given design specifications that allow the content from the pilot to be disseminated into the larger ecosystem of agriculture information. The enterprise functions of these big organizations require leadership from places such as CRS and USAID, which have invested in large-scale projects. Standards should be established so that when large systems are built, they will be searchable and available through multiple ICT channels. Each player in the EAS system has a role to play in the development of ICT.

Future Research

The need for future research is substantial. The growth of mobile subscriptions means that researchers must find ways to make mobile information, including banking, accessible to rural farmers. These mobile applications must have impact and improve productivity. Researchers need to convey quickly what works, or private entities such as mobile network operators and other for-profit private organizations will increasingly experiment with applications by which they make money without ensuring that farmers will become more productive. Influencing public/private partnerships will become essential for EAS. Mobile applications far and away will be the fastest growing ICT tool, but coupling mobile with pervasive radio could make mobile even more powerful.

The educated players in the EAS system must quickly begin to search for low-cost and scalable Internet applications, including e-learning, open databases, improved search processes and enterprise designs. It is likely that EAS will need to learn from developing countries and various industries. It is essential that EAS find Internet applications that can be adapted to agriculture. One such example is the Agri-Drupal platform created by the FAO, which customizes an open source content management system (Drupal) so that it incorporates the AgroVoc Thesaurus used by the FAO to catalog agricultural information. The FAO has linked a low-cost tool and longstanding cataloging process to provide a new content management tool for other large organizations. These large-scale ICT efforts are examples of what the EAS community must pursue to become more effective.

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