Reaching the last mile:

Best practices in leveraging the power of ICTs to communicate climate services to farmers at scale

Working Paper No. 70

CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

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Photos:

Abstract

This report reviews key ICTs for Development (ICT4D) Programs, Innovations and Information Exchange Platforms which are experimented within South Asia to explore the use and scale-ability of these innovative approaches to other parts of Africa and the developing world. Learning from the pioneering experiences of pilot projects across India and Africa in ICT development, we assess the potential ICTs offer to not only communicate climate information and related advisory services but also to build capacity and increase the resilience of rural smallholders. It is our hope that such South-South learning can pave the way for improved cross-regional experience sharing to tackle common challenges in reaching 'the last mile' with salient rural extension services, including climate information services.

Keywords

ICTs; climate information services; India; Africa; information exchange platforms

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Contents

Acronyms

AFFRI	Africa Farm Radio Initiative
AR5	Annual Report 5
CCAFS	CGIAR Research Program on Climate Change, Agriculture and Food Security
CGIAR	Consultative Group on International Agricultural Research
CKW	Community Knowledge Workers
COE	Centre of Excellence
GEF	Global Environmental Facility
ICAR	Indian Council for Agricultural Research
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICT	Information and Communications Technology
ICT4D	Information and Communications Technology for Development
IDRC	International Development Research Centre
IFFCO	Indian Farmers Fertilizer Cooperative Limited
IPCC	Intergovernmental Panel on Climate Change
ISRO	Indian Space Research Organisation
KVK	Krishi Vigyan Kendra
MSSRF	M.S. Swaminathan Research Foundation
NGO	Non-Governmental Organization
NAIP	National Agricultural Innovation Project
NSSO	National Sample Survey Organization of India
RKC	Rural Knowledge Centre
SMS	Short Message Service
UNCCD	United Nations Convention to Combat Desertification
UNEP	United Nations Environment Program
USAID	United States Agency for International Development
VKC	Village Knowledge Centre
VRC	Vocational Rehabilitation Centre

Introduction

Food production will need to increase by 60% to meet the demand of the world's growing population, which is expected to reach 9.1 billion by 2050. Smallholder farmers practice rainfed agriculture on more than 80% of the world's farm area and currently generate almost 60% of the world's staple foods. They will thus have a significant role in ensuring future food security and economic development in developing countries.

Smallholder farmers are highly sensitive to extreme climatic events due to their heavy dependence on rains, surface water and lack of access to appropriate scientific knowledge and modern agricultural methods and practices. The recent IPCC report (AR5) concluded that increased frequency of heat stress, drought and floods negatively affect crop yields and livestock beyond the impacts of changes in the mean climate. Although crisis management approaches are widely practiced by national and international organizations, controlling, managing or providing relief from multiple extreme events is not easy and may be impossible, leaving smallholder farmers with no other option but opting out from agriculture as a final coping mechanism to sustain their livelihoods.

The National Sample Survey Organization of India (NSSO) in 2003 reported that over 40 % of farmers would quit farming if they had the choice to do so, because of the high risk involved in the agriculture occupation. The extension systems that played a key role in advancing food security during the Green Revolution are inadequate in terms of infrastructure and human resources and not in a position to satisfy the information and knowledge needs of smallholder agriculture under a changing climate.

According to United Nations Convention to Combat Desertification (UNCCD), preparedness is recognized as the preferred way to cope with climate change by relief and crisis response, wherein information is the key. Advancement in Information and Communication Technologies (ICT) provides us an opportunity to bring this into practice. Based on our earlier experiences and as revealed by national and international reports, we are in the view that access to the right information at the right time through the right channels enables smallholder farmers to make informed decisions to prepare themselves for adverse climatic conditions, thereby improving their productivity and profitability while managing risks. This further directly

contributes to their income level and household facilities and indirectly to food and nutrition security. Information dissemination is thus identified as a major driver for addressing the issues of climate change, poverty alleviation, food security, and managing natural resources for sustainable and inclusive development worldwide.

ICTs generally refer to innovative tools, often a suite of specialized products and services that improve access to information and communication between an information producer and consumer. In terms of smallholder farming and livelihood development, what has come to be known as ICTs for Development (ICT4D), links scientific and extension experts with rural farmers, and can provide needed and pertinent information so that farmers can make more informed decisions.

In recent years, ICTs are increasingly being used to create and disseminate agriculture and climate information to rural smallholders in the regions like South Asia and Africa, opening spaces for two-way exchange of knowledge across geographic scales. There is broad anticipation that ICTs will provide farmers with timely and user-friendly information that can positively impact their farming and livelihood decisions (Glendenning & Ficarelli 2012; Jost 2013, Guntuku et al. 2011, ICRISAT 2013a, 2013d). If ICTs are to truly maximize their potential for improving adoption of information and technology by farmers, realizing impact pathways and increasing farmer resilience, especially in the face of a changing climate, they should provide information that is local and context specific (Glendenning & Ficarelli 2012; Jost 2013, Gakuru et al 2009).

ICTs can also improve weakened extension services and contribute to bridging the gap between agriculture and climate experts on the one hand, and rural farmers on the other (Dixit 2006, Guntuku 2011). When smallholders contribute their observations and information needs to the experts, ICTs can facilitate the creation of locally specific agricultural and climate data and advisory services. In order for ICT projects to succeed however, it is widely agreed that they should be created and disseminated with rural farmers' interests in mind. A number of criteria have been outlined that ICTs should meet (Jost 2013; Dixit 2011, Glendenning & Ficarelli 2012). These include the following:

1) ICTs should not only reach farmers but also provide a range of interactions. For example, ICTs can offer one-way (from expert to farmer or intermediary) or two-way (either from farmer to source or face-to face) interactions (Jost 2013).

2) The information provided through ICTs, like other climate information services, should be salient, credible, and legitimate (Cash et al 2003, Hansen et al 2011). As Cash et al. (2003) contend, salience is found when information is relevant to farmer's decisions; credible information has scientific accuracy and authority; and legitimacy is found where information is fair and unbiased and is relevant to the user's context. 3) Projects should be sustainable enough to continue beyond pilot versions and should help produce what Jost (2013) calls a rich "information environment." In addition, sustainability can be insured through ongoing project evaluation and understanding of the dynamics surrounding program planning (Guntuku et al. 2011).

It can be argued that ICTs are most useful when the social processes for creating and transferring knowledge within a community are paid attention to. Rural communities should not be underestimated for the role they play in the transfer of information into knowledge (Guntuku et al. 2011; Tall 2012). Through contributing to the production of knowledge, rural communities will have greater ownership of that knowledge. Simply put, rural farmers are not just consumers of information, "but also partners in knowledge management" (Guntuku et al. 2011:5).

This report reviews key ICT4D programs, innovations and information exchange platforms experimented within South Asia and Africa to explore the use and scale-ability of these approaches to other parts of Africa and the developing world. Learning from the pioneering experiences of pilot projects across India and Africa in ICT development, we assess the potential ICTs offer to not only disseminate information but also build capacity and increase the resilience of rural smallholders. It is our hope that such South-South learning can pave the way for improved cross-regional experience sharing to tackle common challenges in reaching 'the last mile' with salient rural extension services, including climate information services.

In the first section of this report, we provide a brief overview of innovative projects and best practices of ICT and information exchanges in South Asia and explore successful strategies in developing and implementing ICTs. In the second section, we turn the lens to Africa and provide an overview of available technologies. We then discuss how successfully the practices from South Asia may be scaled up and applied to Africa. Finally, we conclude with policy recommendations for facilitating the transfer of best practices from South Asia to CCAFS sites across Africa.[1]

1 Dileepkumar Guntuku's team at ICRISAT is already making their project scalable and applying to Africa through their South-South exchange and developing projects with the World Bank. For similar

Part I. Best Practices in ICTs for Development in India

ICT4D are meant to address knowledge gaps between rural farmers and experts with knowledge on climate, agriculture, or any other development relevant topic to support the livelihoods of struggling rural farmers. India offers one of the best examples of successful use of ICT4D to communicate information services with farmers. There are several practices that have been implemented by India's successful ICT projects, in part to ensure that communities have some ownership in the process and results. These practices include conducting needs assessments, mobilizing communities and ascertaining their interests, and training rural residents to participate in the creation and dissemination of information to their neighbours.

The current design and implementation of ICTs in India attempt to address the past emphasis on top-down approaches by incorporating farmer's/users' needs and inputs while also including marginalized populations (Guntuku et al. 2011). By creating effective partnerships with local organizations, external agencies, and creating bottom-up as well as top-down information flows (two-way) with community mobilization, current ICTs in India are addressing identified challenges for effective information creation and dissemination.

It should be noted that ICT development in India is not just dependent on the latest cutting edge internet savvy technology, but also on more traditional forms of communication, such as face-to-face interactions and low-tech approaches, which includes the use of landlines, radio, and television (ibid).Below, we present an overview of key ICT projects currently ongoing in India that can influence and inform ICT development in Africa. Some of these projects are directly tied to ICRISAT, though others are not (see also Glendenning & Ficarelli 2012 for a recent overview of ICTs in India).

1. Village Knowledge Centres (VKCs)

The use of ICT in India has a lengthy history and there are some important aspects that paved the way for current success in creating two-way information platforms between rural farmers and scientific experts. Most importantly, the network of Village Knowledge Centres (VKC) and Rural Knowledge Centres (RKC) provide a strong

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work at IFPRI see Glendenning & Ficarelli 2012 who provide a thorough overview of six ICT projects launched in India.

base from which other ICT projects in rural areas of India have launched. VKCs were originally created as an experiment to find the most effective way to disseminate information to smallholder farmers (Guntuku, pers. comm., 2013).
In the early 1990s, Vocational Rehabilitation Centres (VRCs) and VKCs were experimented with by the M.S. Swaminathan Research Foundation (MSSRF) in the Information Village Research Project with financial support from the International Development Research Centre (IDRC) (Canadian Development Cooperation) in Pondicherry as test platforms for transferring valuable information, building capacity of local farmers, and developing open distance learning through two-way communication channels (Dixit et al. 2006; Guntuku et al. 2011; ICRISAT a). They were rendered operational through international and national collaborations and built using participatory frameworks that first ascertained village needs and established multi-village hubs and then it offered shared access point to innovative ICT tools where farmers could go to retrieve information, discuss issues with trained agriculture extension agents or trained village intermediaries, and access the knowledge and knowhow of experts about a multitude of farming topics (from crop varieties to markets) (ibid). Dixit et al. (2006) point to the influence of the key philosophical underpinnings of Gautama Buddha, Swami Vivekananda, and Mahatma Gandhi on the development of VKCs; notably the focus on meeting the needs of the rural poor without discriminating by "age, sex, religion, gender or caste" (Dixit et al. 2006).

The farmer-farmer demonstration model was highly successful in transferring information, first through expert-farmer training and then providing support for farmer-to-farmer peer trainings (ibid). The MSSRF in the early 1990s attempted to build on existing information networks and create a "pro-nature, pro-poor, pro-woman orientation" within technological developments in rural communities (Guntuku et al. 2011; Dixit et al. 2006).

Within this framework, the Addakal VKC is often hailed as a model of success (Guntuku et al. 2005; Dixit et al. 2006; Kumar et al. 2007; Ganapuram et al. 2009; Mandai 2009; Neelam et al. 2011; Kumar et al. 2011; Meera et al. 2012). Addakal was established as an experimental project in 2002 by ICRISAT with initial financial support from the State Government of Andhra Pradesh when the region was badly hit with a severe drought and attracted the attention of the international community (Dixit et al. 2006; Kumar et al. 2007). Addakal is said to impact over 46,000 people across 37 villages (that includes 21 revenue villages) in Andhra Pradesh state. The creation of Addakal began with a participatory approach to create a centralized hub of information, farmer training, and communication. Addakal worked with a local micro-

credit women's organization to first establish itself within the area. At first, high-tech systems were not used at the centre. Instead, basic climate and farming information was collected using local volunteers. Local intermediaries were trained on farming techniques/problems and how to collect samples or data about farming and weather. The first ICT-enabled information dissemination application was a web-enabled information exchange platform (to enable interaction between ICRISAT scientists and farmers in Addakal) integrated with hanging blackboards outside of the VKC's doors to advertise offerings and disseminate information. The centre built a system of assistance and worked with agriculture extension officers and national information hubs to produce useful information for communities.

After establishing itself and building trust with nearby communities, Addakal expanded to include computer technologies, the training of local intermediaries in computer use and the building of electronic and paper repositories of common questions and answers. The Indian Space Research Organisation (ISRO) came into the process and provided satellite two-way video links to enable a synchronous mode of communication that allowed rural farmers to interact with experts at ICRISAT and attend virtual classes. The Addakal centre used both low and high tech information sharing and now is a valuable resource for farmer-expert interaction, knowledge sharing and knowledge creation.

Presently, VKCs are run by different companies, civil society organizations, corporations, research institutions, and the government. Through *Knowledge Hub Consortiums,* they create a centralized base for knowledge and enable open distance learning through two-way interactions between scientists and farmers. Trained local intermediaries not only communicate between experts and farmers but also gain the skills to directly help address community-identified needs. In 2007, the Indian government set a goal to create a knowledge centre in every village though a program called National Alliance for Mission 2007-*Every Village a Knowledge Centre* (Dixit et al. 2006).

This project aims to establish 600,000 knowledge centres in the next few years and link public and private sectors with academia, mass media companies, and civil society organizations (ibid). The goal is to provide open distance learning to those with little to no education or backgrounds. However this has not materialized as mobile-mediated information communication mechanisms have provided a pathway to establishing mobile village knowledge centres.

Key lessons from VKCs' success include a focus on slowly developing trust, assessing local needs, and using a participatory approach to create and transfer knowledge. Another lesson includes incorporating two- and three-way knowledge transfers, that is between scientists-farmer or more commonly scientists-intermediaries-farmer. Furthermore, VKC development is built upon a foundation and infrastructure that has been over 20 years in the making. VKCs are built on the partnerships with academia, civil society organizations, and community based organizations. The success of VKCs provided evidence to the national government about the necessity to develop the political will to expand this program across the country in the hopes of building rural farmer's capacity and resilience through increased access to key services like the internet, phone, radio, and expert information. Although the program has expanded and taken the shape of Common Service Centres (which still exist), it did not achieve the set goal of a knowledge centre in every village. Governments found that mobile-mediated platforms could address the infrastructure and human resources challenges that are substantial both in traditional extension systems and to some extent in the VKC model.

2. Mobile Phone Applications: SMS and Voice Messaging

With the mobile revolution that hit India, along with the rest of the world, mobile phone ICTs have begun quickly expanding to directly reach farmers with information and for farmers to directly interact with experts on an individual basis. Mobile phones also provide support to the rural intermediaries and extension agents to more accurately and quickly answer farmers' questions and provide real time relevant information. There are a number of mobile phone ICTs in India. Krishi Vigyan Kendra (KVK) is a pilot project involving the National Agricultural Innovation Project (NAIP) of the Indian Council for Agricultural Research (ICAR) and ICRISAT.

This project focuses on mobile technology that "centres on expert-farmer-expert communication" using mobile voice messaging and was designed to send agricultural and weather advisories to farmers using mobile phones (Dar 2012). The overall goal of the KVK system is to enable three forms of communication, namely expert to farmer, farmer to expert, and expert to expert. A recent popular media article in *The Hindu* states that 3,000 farmers in 3 districts are currently using the service, with as many as 95-98% of farmers accessing their messages (Sivanandan 2012).

In a joint venture launched in 2011, Airtel and the IFFCO began offering innovative "mFarmer" services. The Green SIM card operates like a normal mobile SIM card with additional features that links farmers to climate and other agricultural information.

At the outset, farmers purchased the Green SIM, used it as a normal SIM card and then, as subscribers, received pushed SMS messages with farming information. At the start, there was a need for intermediaries on the user's end to translate messages into local languages or read the messages to illiterate farmers. Now, the voice message system works through intermediaries, often local extension officers, who receive pertinent farming and weather advisories, translate the messages into local languages and send them out to subscribers.

The Green SIM offers voice messages of relevant information on topics ranging from weather reports to information about pests to the status of crop markets. Farmers can receive the voice messages free of cost (Mihanty 2009; Thomas 2011). The Green SIM does not just benefit 'subscribers,' but it also provides incentives for local information intermediaries to earn commission money by selling the SIMs. Intermediaries are also becoming conduits for building trust between the source of information and end users (Guntuku pers. Comm., 2013).

Other successful mobile phone based ICT projects in India include the Reuters Market Light and Lifelines. Reuters Market Light was launched in 2007 and offers mobile SMS to subscribers with information about crop advisories, weather data, and market prices for crops. Partners in various private and public fields, including the Indian Meteorological Department, provide the information. Market Light is said to reach 1 million farmers in 40,000 villages and provides SMS in eight local languages in 13 states. The Lifelines project began in 2006 and is sponsored by OneWorld.net, a UK based NGO, British Telecom, and Cisco Systems. Lifelines reaches 150 thousand farmers in 2000 villages. It is built on private-public partnerships and links local NGOs to farmers. The platform allows farmers to query experts through a Q&A platform that provides voice responses (Glendenning & Ficarelli 2011).

3. Participatory Extension Video Approaches

The importance and usefulness of digitizing the scientific knowledge and bringing that to the farmers' door steps is recognized through participatory extension video approaches' run by innovative ICT tools such as battery operated pico-projectors or projectors integrated with mobile phones in Farmer Field Schools approach. One

such initiative is by Digital Green in using the participatory extension video approach, where in best management practices and other scientific knowledge available on crops will be converted into small video capsules involving farmers and will be used to educate the fellow farmers of the same community.

4. Centre of Excellence (COE) in ICT Innovations for Agriculture

The Centre of Excellence (COE) in ICT innovations for Agriculture is an interdisciplinary platform of ICRISAT launched in 2012 during 40th anniversary celebrations. The COE platform aims at bringing ICT innovations in agriculture by integrating science, technology and value chain approaches to design and develop affordable technologies, new tools, platforms, methods etc. that support knowledge transfers, extension, capacity building activities etc. The platform capitalizes on a coalition of strategic partnerships led by ICRISAT. The partners come from diversified areas to work on a specific global issue/problem – ranging from climate change to global food security, enhancing traditional extension and education systems, access to markets and quality inputs etc.—and as an interdisciplinary group thereby contribute to the innovative solutions.

Since its inception ICRISAT has developed and sustained many ICT innovations in linking research-extension-markets for agriculture and rural developments such as a framework for Micro-Level Drought Preparedness, Open Access Repositories, AgriLORE, Agropedia, Virtual KVK, KSIConnect etc. The proposed platform will allow ICRISAT to expand and scale up proven successful ICT innovations in agriculture together with partners across the globe.

One such proven successful ICT platform – Krishi Gyan Sagar and Krishi Vani powered by the Green SIM—has emerged from the COE and is spreading across different parts of globe demonstrating ways to set up financially sustainable ICT4D platforms for dissemination of the right information services to farmers combined with quality inputs at the right time through the right channels.

Krishi Gyan Sagar and Krishi Vani—powered by Green SIM – brings the best of affordable technologies, knowledge solutions, availability of quality inputs, credit and insurance to smallholder farmers' doorsteps through appropriate ICT mediated tools and value chain approaches anchored in public-private partnerships.

The **Krishi Gyan Sagar** application supports both tablet/smart phone functionality as well as web usage. The app consists of various modules for executing several information and input delivery services, including a soil health module; crop knowledge base; improved farm management videos; farmer-field-crop record database; officers and expert database; buy and sell virtual transaction platform etc. In addition to these features the web based application offers a report generation feature. This feature helps to generate quick reports, market intelligence and an intelligent decision support system for improving productivity and profitability. Apart from the buy and sell module other platforms are in use, and plans are underway to implement the buy and sell platform as well to bundle quality inputs together with information services.

Krishi Vani is a mobile mediated agro-advisory platform that delivers voice messages in 16 categories (including weather, market, crop information, government schemes, nutrition, health etc.) in regional languages. The platform is built on public-private partnerships to ensure financial sustainability. Based on the pilot project experiences in three different experimental hubs ICRISAT and partners are of the view that many ICT models are in progress and providing promising results, but have failed to establish financially sustainable frameworks, as that requires the incorporation of a multiplicity of actors of both public and private sectors to achieve long term financial sustainability.

The Krishi Gyan Sagar and Krishi Vani powered by the Green SIM is an effective platform to establish the 'last mile' connectivity to smallholder farmers. With useful information inputs in local languages and voice format, the system is improving the quality of decision-making among smallholder farmers. The system successfully demonstrated a digital inclusion approach to improve farm productivity, promote sustainability and resilience of farming systems by enabling climate and crop information services, directly improve income, livelihoods and household food security, and indirectly, of health and nutrition.

The rise of new ICT devices such as tablets, phablets and other handheld devices will create new opportunities for user-friendly information tools for better agricultural advisory services along with informing farmers about quality inputs and market access. It will also create job opportunities for info-entrepreneurs that can bring crucial added value for farmers. The platform recently received the Flame Award 2013 for 'showcasing innovative use of technology of the decade' and plans are

underway to replicate this model throughout India and parts of selected African countries.

5. South-South Initiative

The ICRISAT South-South (S-S) Initiative aims to "provide a platform for focused and systematic international relationships critical for a more effective and inclusive development cooperation between India and Africa" (ICRISAT 2013b). The S-S Initiative is ICRISAT's attempt to scale up India-Africa partnerships regarding dry-land specific issues through working on policy, building institutions and infrastructure, and increasing market access. There are four programs through which the S-S Initiative will be carried out. These include science-based innovations, agri-business incubation centres, food processing clusters, and knowledge centred learning innovation. The last of these is of central importance in terms of ICTs, as there is a push to scale up ICT4D models and tech-based extension services from India to Africa. Also included in this program, is an emphasis on virtual training and capacity building of stakeholders ranging from extension agents to scientists to farmers.

Successful Strategies in ICT

In providing an overview of key ICT programs in India, we highlighted some of the successful strategies that were utilized. There are a few key elements that many of the ICT projects incorporate. It seems that the most 'successful' are those that have a few overlapping themes/elements. First, there is substantial evidence that two-way communication is effective in meeting the critical criteria of salience, credibility, and legitimacy.

When farmers are allowed to access databases or experts (or their intermediaries) to query their own concerns, greater ownership and relevance of information to farmers' needs is observed. Some of the projects are also able to utilize local observations and data collection to inform experts, giving farmers added buy-in to the outcomes and participation in knowledge creation. The example of the VKCs demonstrates the time that is needed to build relationships and the value of participatory needs assessment.

Another key element is the strong public-private partnerships that are involved with making ICTs operational and successful. Other critical relationships are those involving tech companies, local NGOs and other organizations, as well as having a direct link to experts in research institutes or university settings. A mixture of top-down and bottom-up processes with community mobilization is a critical component

to project success. Third, political will and support from the state appears to be an important factor in ensuring that everything from favourable policies to collaboration with extension agents is in place.

Summary of best practices in India:

- Robust public-private partnerships
- Collaboration between local organizations, national agencies, research institutes, universities, and public companies
- Strong extension services—bolstered through empowering with ICTs or,
- Training intermediaries from local communities to do outreach, learn to use and train others on ICTs, communicate with experts
- Support and investment in growing IT infrastructure
- Long-term investment by government and civil society actors in policies that expand information availability to rural smallholders
- Commitment to bottom-up processes
- Two-way communication platforms, building farmer-expert modalities into ICT
- Farmer contribution to knowledge systems
- Use of local languages in ICT delivery
- Use of SMS and Voice-Messaging systems
- VKCs—long term investment and projects that can be expanded as technologies and issues change

Part II. ICTs in Africa

Background

There are a number of ICT programs across Africa, including several at CCAFS sites. These programs span the array of available technology, from SMS messaging to radio broadcasts to training agricultural extension agents. There are also several pertinent reviews of ICT and climate information service projects that showcase key ICT technologies being used in Africa (see Jost 2013; Gakuru et al 2009; May & Tall 2013; Tall 2013). In a 2009 study, *Inventory of Innovative Farmer Advisory Services using ICT* (Gakuru et al 2009), researchers noted a shift toward using mobile technologies to disseminate information to farmers across Africa.

In 2013 CCAFS also published a working paper, "Delivery Models for Climate Information in East and West Africa" which offers an updated overview of the development of ICTs in Africa (Jost 2013). This report provides a thorough literature review of ICT projects across the continent (and as they pertain to CCAFS sites). Not only were academic, white paper, and internet literatures reviewed, the projects were reviewed using critical criteria to determine their relative 'success', namely regarding salience and legitimacy.

Jost et al. also conducted a questionnaire about information delivery in eight CCAFS priority countries across Africa. The questionnaire surveyed experts from national meteorological services, agriculture services, extension services, agricultural research organizations, agribusiness organizations and companies, national farmer associations, communication companies, local development NGOs, international NGOs, and international organizations. It is unnecessary here to repeat the findings of these two key reports; however, we present some of the most critical findings that are relevant to the goals of this report, alongside additional data about ICTs that exemplify appropriate technologies that are spreading across the continent.

In addition, we reviewed a number of prominent climate adaptation programs to explore their use or funding of ICT for agro-climate services. All of the projects are jointly funded, planned, and operated with participants ranging from governmental and parastatal organizations to private foundations and corporations to local NGOs and farmer associations who often are key drivers for on-the-ground project implementation.

The history of ICTs in Africa is linked to the history of development—that is, it is similarly punctuated by phases of decentralization, privatization, and state intervention—though this is country-dependent (Jost 2013).

There are increasing efforts to support ICTs in Africa by international organizations, governments, companies, and NGOs working with government run meteorological agencies, who are often lacking in resources (UNDP, N.d.). Of all the ICT projects reviewed (in overview reports and for this report), information is primarily generated by state meteorological agencies with assistance and input from international climate partners and disseminated through extension agents, when they are available. Since agriculture extension services have decreased across Africa because of the push towards decentralization and privatization of services, there appears to be an increased reliance on taxed extension services or training of local intermediaries to help disseminate information to rural farmers.

There are also several key organizations that serve as umbrellas for large scale ICT and climate service project developments in Africa including the United Nations Development Program (UNDP), the United Nations Environment Program (UNEP), CARE-World Vision, Farm Radio International, and the Red Cross/Red Crescent Climate Centre. Private corporations, such as Airtel, are working in partnership with a number of these umbrella organizations to round out many of the public-private partnerships that ICT development relies on.

The goal of some of these collaborations is to invest heavily in building infrastructure and technological capabilities for information generation and dissemination. For example, in 2012, UNDP and the Global Environmental Facility (GEF) in their Joint Adaptation Learning Mechanism program began providing support to a number of countries across Africa to build technologies and key infrastructure that will support collecting, analysing, and disseminating climate information and early warning systems (www.undp-alm.org).

Technologies and trainings supported by UNDP-GEF include weather stations, forecast technologies, computer systems, and communication systems to disseminate the information they generate. Their Eastern and Southern Africa program is concentrated in Ethiopia, Malawi, Tanzania, Zambia, and Uganda and has a multi-year budget of over $126 million. The West and Central Africa program is centred in Benin, Burkina Faso, Liberia, Sierra Leone, and Sao Tome and Principe with a multi-year budget of $96 million (UNDP, N.d.). While this information points to large-scale infrastructure development, there are many smaller-scale ICT projects that are already underway or are rapidly rising across the continent.

Available ICTs in Africa

Gakuru et al. (2009) group ICT projects across the continent into four main categories, namely, voice information delivery, radio broadcasts, mobile platform based extension services, and e-learning. Half of these are pilot projects. According to Jost, there are six main types of ICT that exist to varying degrees in Africa. These include mobile phones, radio, internet, telecenters, agriculture extension services, and TV or print media. A number of projects that utilize ICTs, including SMS, radio, and knowledge banks, are evaluated in May and Tall (2013).

This report reviewed a number of ICT programs that appeared frequently in literature and internet searches on ICTs in Africa, such as the Uganda Grameen Development program discussed below. As observed, literature on ICTs often points to the importance of evaluating climate services and ICT projects for salience, credibility, and legitimacy. Recommendations for future ICT projects describe these criteria as integral to project success and ending top-down only methods and information (see Gakuru 2009; Jost 2013, Tall 2013, May and Tall 2013).

Below, we offer key ICT formats that are rising in importance across Africa (for comprehensive reviews see Jost 2013, Gakuru 2009; May & Tall 2012). Some of the examples provided for each category of ICT are expanded in other reviews, though because information and communication technology changes rapidly and because a number of projects are only in testing or pilot phases, continual review and analysis will be needed. We present relevant examples from programs that are often cited as examples of success (through reports, donor organizations, research institutions developing new tools, and online media). These include:

1) **Radio:** The use of radio has been deemed the most successful and most adopted ICT in Africa, and farm based radio programs/initiatives exist in all CCAFS countries

in Africa (Senegal, Mali, Ghana, Burkina Faso and Niger). Radio based ICTs can offer live and pre-recorded programming, information about points of contact and centers that are internet connected, and/or databases of information for farmers. The Africa Farm Radio Initiative (AFRRI) and Farm Radio International are prime examples of ICTs that are not limited to radio only. AFRRI operates in five CCAFS countries (Ghana, Malawi, Mali, Tanzania, and Uganda) and provides radio programming, agriculture services training, participatory programming, SMS and voice messages, computer/internet facilities, and call centers for listeners and communities. AFRRI donors include a host of US and Canadian based private foundations (e.g. Gates Foundation), international organizations (e.g. World Food Program, World Vision), an assortment of government aid programs (e.g. USAID, Irish Aid), and agriculture-based research organizations (e.g. ICRISAT). AFRRI program success is dependent on the input listeners provide to the programming as well as a media blast of information about upcoming programming and trainings, including the use of SMS alerts. Though radio has the potential to reach the most people in the African context, many local stations have small ranges (Jost 2013). (See Farm Radio International for more information: http://www.farmradio.org/).

2) Agriculture Extension Services: Extension services have been the backbone of agriculture information dissemination in Africa, though this is waning in many countries (Jost 2013; UNDP N.d.). Agro-advisory services that incorporate climate information through mobile platforms are increasingly being utilized as key intermediaries in disseminating information (Jost 2013, Gakuru 2009). These intermediaries, once primarily government agriculture extension agents, now include government workers, locally trained village residents, and staff of local or international NGOs. ICTs facilitate information transfer between experts and farmers using varying types of technologies, and they do not have to be limited to agriculture extension services. Agricultural advisory services are increasingly available beyond extension agents and also incorporate farmers. A key example of a successful ICT project that highlights the importance of these local intermediaries is the Grameen Foundation AppLab program in Uganda. Grameen Uganda is using SMS messaging to disseminate Mobile Weather Alerts (Grameen Foundation 2013; Tall 2013) to farmers. The program has trained Community Knowledge Workers (CKW) who receive these mobile alerts and additional climate and farming relevant information by smartphones and then disseminate these using local languages and local contexts. CKW has also received training to collect survey data, local ideas, and data from their communities. As a result of these local inputs and work with local partners, locally specific farming and climate information is compiled into a living database that

experts and residents (through intermediaries) can access (for more information see http://www.grameenfoundation.applab.org).

3) Mobile Phones: As discussed above, other ICT programs rely on mobile phones to implement or supplement their programs. Mobile phones are not as widely used in Africa as they are in India, though the market is rapidly increasing (M-Kilimo.com; Jost 2013). SMS and mobile banking through programs like Vodaphone's mPesa and Airtel Money are increasingly utilized in urban and rural Africa, and these platforms have also spawned agriculture and climate based information service dissemination. Mobile phone ICTs offer a range of possible points of connectivity, including SMS alerts and advisories, voice mail delivery, and access to call centers where experts may be housed. Mobile phones are not only delivering one-way communication from expert to user, but increasingly, systems are being developed for two-way communication between farmers and experts (Jost 2013; May & Tall 2013). Another example is Airtel Kenya's *Sauti ya Mkulima* (Voice of the Farmer) program, developed out of Airtel India's success. Sauti ya Mkulima offers SMS messaging and on-demand agriculture and weather information. The Airtel program is part of a broader corporate social responsibility framework under the mFarmer Initiative. The mFarmer program was created in partnership with GSMA, USAID, and the Gates Foundation ___(m-Kilimo.com 2013; Airtel 2011, 2013) and delivers pertinent farming information via SMS. It is currently expanding to include a "Farmer Helpline" that directly links farmers to experts.

4) Internet—Telecenters & Community Knowledge Centres (Village Information Centres): E-based learning platforms in Africa offer information transfer that rely on internet connectivity at a community scale. There are variations of community knowledge centers in all CCAFS countries, though their effectiveness differs (Jost 2013). Many of these centers are run by different organizations or government agencies, there does not seem to be any coordination from location to location, and goals and project agendas are not coordinated. A number of these centers are integrated with radio stations or other information services such as libraries, village markets, or phone centers. Their connectivity to the Internet or expert advice or databases is unclear. In our review of ICT materials, the use of community knowledge centers did not readily appear as foundational as in the India context, though a few, like the Grameen Uganda project and those that utilize AFFRI radio resources do seem to offer direct interactions for agriculture or climate information or databases.

5) TV, Video, and Print Media: TV, video, and print media are additional forms of ICT that are used to disseminate agriculture and climate information. TV is less

common than mobile phones and radio in rural Africa, though the use of other ICTs is also tied to TV and print media resources (Jost 2013). Two examples of television programming addressing agriculture can be found in Kenya and in Burkina Faso. The Kenyan programming addresses multiple issues ranging from climate to health, and the programming in Burkina Faso primarily addresses agricultural markets. Print media is still utilized in multiple settings and there is often a link to multimedia and ICTs, such as mobile phone or radio outreach or advertisements. Video-based trainings are also found; however, they usually provide for dissemination at a broader level, thus they sometimes fail to communicate in local languages about locally specific topics (Gakuru et al. 2009).

Successful Practices in Africa and How to Apply ICTs to Reach the Last Mile at Scale

The surveys conducted on existing projects are only one aspect of reviewing ICTs. Jost (2013)'s questionnaire conducted sheds more light about available and successful ICT projects and information. It is important to note that this questionnaire was conducted with "centrally based knowledge experts" and not rural farmers themselves. However, the experts surveyed were often the generators and disseminators of farming and climate information and had firsthand knowledge of the available technologies and methods that are functioning within their countries and regions.

The most "salient, credible, and legitimate" ICTs were ranked as radio, extension services (though Jost notes many respondents of the questionnaire were in those same extension services), and TV. Also of key importance were farmer-farmer information exchanges and SMS alerts and messages. SMS were however seen as more salient and relevant in East Africa than francophone West Africa, where it was seen as less accessible than the Internet. In terms of the desired information that experts thought farmers wanted include first and foremost, onset and end of rain forecasts. The Gakuru et al. review noted that SMS and voice-messages were highly regarded as being critical in the future; however, there is not a one size fits all solution to disseminating agricultural and climate information (2009: 13).

There appear to be some common themes in successful and innovative ICTs in Africa. Many of the most successful ICT projects have traits similar to successful projects in India; namely, they are those that maximize farmer-source interfaces (Jost 2013). The

projects that were successful were able to maximize the two-way or three-way communication, notably farmer to expert or farmer-intermediary-expert interactions, as well as those that solicit farmer input to build databases and disseminate knowledge. Projects are more successful when farmers are able to request information they wanted and needed and hence, increase salience. Successful projects also had increased credibility when farmers and local actors (such as local NGO representatives) were part of knowledge production and translation was done in local languages and within local knowledge systems. In Jost (2013), experts reviewing their own knowledge of ICTs and information sharing more generally with smallholders, noted the importance for making information less jargon filled and to fit the needs and wants of local communities, i.e. information they both want and need.

The most successful models in disseminating information appears to be radio and mobile phone services like SMS and voice mail. Radios are the most widely accessible technology yet mobile phones offer the means to disseminate information and also collect information and facilitate farmer-to-expert interactions and knowledge sharing. Where salient, credible, and legitimate information is shared and created, mixed ICT methods often create an ideal "information environment" (Jost 2013). Finally, it has been suggested that project creation, execution, and evaluation be shared among those working on developing ICTs (Gakuru et al.2009).

Summary of best practices in Africa:

- Radio delivery of information, rural radio stations as localities for information and training
- Extension, where available can be supported by ICT
- TV is effective when available
- SMS and voice messaging with two-way platform built into ICT are increasingly useful and desired
- Internet is not as widely available in East Africa as West, but is important source of information when it is available
- Farmers benefit when they are involved in knowledge production and contribution; ICTs are stronger when they seek farmer input
- Farmer-information source interface is critical, especially when farmers can *seek* information they want and need in their own time
- Creating an "information environment" is a key consideration beyond simple ICT delivery

Conclusions

Lessons Learned From India to Africa

Much of India's success appears to be based on a more robust infrastructure of government programs, policy, and technological basics. India offers more widespread essential infrastructure such as electricity and basic communication services, in addition to progressive government policies and political will to expand ICTs and empower rural smallholders. Africa is diverse and each country has strengths and weaknesses in terms of infrastructure, policy, and connectivity; thus generalizing about the ability to scale-up is challenging. Large telecommunications companies, like Airtel, are themselves Indian based private enterprises. Though Airtel will expand "mFarmer" type systems in 18 countries in Africa (Guntuku, pers. comm., 2013), there is also a long-standing and deep commitment to Indian issues. Projects like Village Knowledge Centres have deep roots, extending back 20 years and with foundations tied to Indian humanitarian philosophies. Also, the network of agriculture research institutes, universities, and agriculture based NGOs directly collaborate with communities, each other, and corporations.

Many of the successes of ICTs in India seem appropriate to expand to the African context, as is being done for example in the ICRISAT South-South Initiative or by private corporations such as Airtel. Several lessons can be learnt from India's ICT development and applied to the African context, where appropriate, whereas others may be less appropriate to export to the African setting. While there is a small but growing network of village information centres in Africa, the program that exists in India are more directly involved in capacity building and engaging farmers directly in disseminating information and creating two or three way networks of communication. VKCs in India began as low-tech centres of information dissemination, slowly building trust and integrating into community information networks. A slow integrative approach to creating a network of VKCs may be able to build on active information centres that are based on providing phone, Internet, radio, or informational services. Local centres in Africa have some infrastructure to conduct things like trainings for farmers and intermediaries and offer services or resources that may be lacking elsewhere in a community, like satellite communication, Internet, electricity, and cellular service. These centres may benefit from coordination, at least regionally. By coordinating programming, partnerships, information available, trainings, technologies, and goals more effective and useful knowledge hubs can be built.

The voice messaging services that are offered through Airtel India also offer promise to be scaled up in the African context. Airtel is already building a farm information service in Kenya and are interested in expanding to all 18 Airtel countries in Africa (Guntuku, pers. Comm, 2013). In Africa, voice messaging is a less common service, but mobile phone technologies are changing rapidly. Call centres with experts available to answer questions in India is also a promising ICT that may be up scaled. Since there is an expansion of infrastructure and expertise in Africa, especially around climate information as recent funding demonstrates, this may be a possibility in the future.

Finally, a number of India's ICTs were developed through building on programs or organizations that were in place. Thus, African ICTs can build onto the most successful programs that already exist, such as rural radio stations. These can be expanded to include more local 'hubs' for information, guidance, resources, and outreach. The programming of local radio can be expanded to include information on climate and agriculture, where they are not already, as well as for bottom-up information such as farmer knowledge.

Developing successful ICTs depends on making them sustainable, as well as salient, credible, and legitimate. Both Indian and African examples demonstrate what can happen when investments are made into long-term public-private partnerships and forge links between experts and local organizations, international funders, and research organizations.

Summary of pre-requisites for successful ICT4Ds in Africa

- Government policies and programs are foundational elements;
- Infrastructure for electricity, communication, building centers is also critical;
- Public-private partnerships safeguard sustainability;
- VKCs in India are based on Indian philosophies; Africa can tap into local knowledge and philosophies and cultural norms to build knowledge centers;
- Engage communities directly through VKCs, obtaining input from farmers for knowledge production, and farmer-expert communication;
- Create intermediaries from local communities; or use ICTs to further bolster extension services
- Indian VKCs are more coordinated; serve as hubs of information dissemination *and* collection.

- Call centers of experts allow for farmer → expert or intermediary→ expert real-time interaction.

Policy Recommendations:

After reviewing best practices of climate information communication from Africa and South Asia, we can recommend some practices from South Asia (and Africa) to be applied at a wider scale. First are some obvious general needs, such as encouraging national governments to use new streams of revenue (from the international community and private corporations) to build and maintain expert infrastructure for producing salient, credible, and legitimate information. Second, as this infrastructure is bolstered, encourage partners to conduct local needs assessment in the most climate vulnerable communities and among the most vulnerable populations within those communities. Third, encourage transparent and supportive policy that provides space for public-private partnerships. Finally, encourage partnerships between research institutions, universities, meteorological agencies, extension services, and local NGOs. Listed below are more direct recommendations for CCAFS and partner organizations to transfer lessons learned and best practices from both South Asia (and Africa) to implement in Africa:

- Encourage private-public partnerships to safeguard sustainability;
- Expand collaboration with cellular companies; expand to new companies, especially those looking for new markets;
- Increase coordination between local NGOs, national/international organizations and agencies;
- Build on existing, established technologies and programs such as rural radio, SMS services, agriculture extension, and local NGOs when available. Building trust takes time and effort; programs that are established have often already done the legwork.
- Expand and support knowledge centers: build on what exists, like rural radio hubs;
- Coordinate knowledge center programming regionally or nationally;
- Tap into local knowledge, cultural philosophies and norms about communication and conceptions of community to build-up knowledge centers;
- Provide knowledge centers with needed infrastructure for cellular service, electricity/solar for phone charging;
- Train more village-based intermediaries;
- Use knowledge centers or rural radio centers to train intermediaries, for outreach, and for information exchanges with experts;

- Create platforms that allow for two-way communication; allow farmers to directly interact with and access experts or intermediaries about their individual needs;
- Build call center systems, collaborate with regional research institutions, universities, NGOs, government departments to equip call centers with expertise;
- Allow for input from farmers to inform and expand knowledge that is disseminated in real time.

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