ICT and Agriculture in the Context of Green Growth

Neil Palmer, CIAT

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ICT IN AGRICULTURE

Connecting Smallholders to
Knowledge, Networks, and Institutions

The World Bank, in collaboration with the e-Agriculture community and the Food and Agriculture Organization of the United Nations (FAO), is holding a series of two week online forums. These e-forums stem from the launch of the World Bank's *ICT in Agriculture e-Sourcebook* (2011) and the growing demand for knowledge on how to use ICT to improve agricultural productivity and raise smallholder incomes. The following summary captures the discussion during one of these e-forums. *The text is derived strictly from the participants' posts during the forum and does not reflect the views of the World Bank or FAO.*

Climate change and "green growth" are at the top of the agricultural development agenda. Limited resources, population growth and environmental concerns all challenge agricultural productivity. This forum considered how information and communication technologies (ICT) can be used to advance climate-smart agriculture, which is defined as actions that "seek to increase sustainable productivity, strengthen farmers' resilience, reduce agriculture's greenhouse gas emissions and increase carbon sequestration, while it strengthens food security and delivers environmental benefits" (World Bank, 2011).

The forum focused on two main components: 1) ICT as tools for land use planning and management, and 2) ICT as risk management tools for climate change adaptation. It builds on two *ICT in Agriculture e-Sourcebook* modules: *Increasing Crop, Livestock, and Fishery Productivity through ICT*, and *ICT Applications for Agricultural Risk Management*, with the aim of identifying new trends and ICT tools that hold promise for green growth.

ICT Tools for Land Use Planning and Management

> *ICT has created unprecedented linkages between public and private institutions, governments, citizens and corporations.*
> *Ndubuisi Ekekwe*, African Institution of Technology

ICTs to improve land management (e.g. soils) and land use planning

Among the various ICT, Geographic Information Systems (GIS) and Remote Sensing (RS) techniques represent two key tools for land planning and management. GIS offers the opportunity to gather multiple layers of information, drawn from different sources, into one spatial representation. This can be particularly

useful in reaching consensus over land planning when users have different values and preferences linked to a given territory. Similarly, RS techniques are a valuable tool for monitoring land resources (e.g. vegetation, water bodies, etc.), especially when a single institution is in charge of monitoring a wide area.

Retrieving data directly from the field is expensive and time consuming. Nonetheless, GIS and RS cannot completely substitute for local, on the ground observations. Finding the appropriate balance between remote and in-situ monitoring is often a delicate issue. To overcome some of these challenges, it is essential to inform GIS and RS frameworks through participatory processes in order to identify appropriate and transparent methods and systems. The process behind the deployment of GIS and RS should be open and explicit so communities do not perceive the technologies as tools for hidden agendas.

One objective of climate-smart agriculture is adaptation. How do land use planners, farmers and service providers think about changing whole farming systems in response to climate change? This "transformative adaptation" is more advanced in developed countries such as Australia, however, it has potential in developing countries as well. One tool for adaptation that is now being worked on, which combines GIS and modeling, is known as "analogue sites" (see Applications/Resources section for more information about this and other tools and processes mentioned in the forum).

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The toughest challenges may be identifying the target group of farmers where these efforts can make the most difference, and in determining the ICT that will provide the most robust access to the relevant information within budgetary constraints. Generating awareness about the availability (e.g. through government-sponsored extension), and farmer acceptance (long-term social behavior changes) of these tools, are also challenging but critical aspects to sustainability.

Using ICT to make farming practices more environmentally sustainable

In many developing countries, farmers determine fertilizer usage, with retailers (input sellers) typically playing an important role. Studies and practical field experience show that farmers do not often use the proper dose and chemical type due to lack of appropriate knowledge and other reasons, which in turn leads to increased production costs as well as harm to human health and the environment.

One ICT-based solution to this problem is found in the e-Krishok program in Bangladesh. The Fertilizer Recommendation Solution (FRS) is an online tool that guides farmers to know the right dose and type of fertilizer to be used for a specific location and crop. Farmers can also receive a printout of their diagnostics at a local telecenter or information center.

Beyond nutrient management, there remains a great need for innovation in the use of ICT for the management of agriculture's impact on the environment, including water. Integrating the power of ICT into irrigation management is a high priority need in this area.

While promising, the use of ICT to make farming more environmentally sustainable faces many challenges. The FRS experience demonstrated that raising awareness of these services and their benefits amongst small farmers is a significant challenge to overcome. Once awareness is achieved, then trust and liability (i.e. what if the information used leads to an adverse result?) become critical.

> *According to the [farmer] it was absolutely absurd that someone, who he can't see, would recommend the exact amount of fertilizer to be used in his land without even seeing his land! To him it was a ridiculous idea and in his 35 years of career as a farmer he never heard of something so absurd.*
> Md. Asad-Ur-Rahman Nile, Katalyst, from discussion with famers in Bangladesh

The challenges that face any agricultural activity involving the use of ICT, such as poor connectivity, low bandwidth, limited electricity, high mobile service costs, user-based/need driven information, are the same facing the potential of ICT to make agriculture more environmentally sustainable. These challenges can be at least partially overcome by service providers that develop reliable rural connectivity, alternative power resources for electricity, and by involving the relevant client groups to define what types of information and knowledge will be useful to them from the onset. Importantly, messages need to be tailored to particular contexts in order to be appropriate and have value to farmers. Integrating local data collectors into the design phase will help to ensure this value.

It is also important to share the limitations of these technologies with farmers. For example, adopting the information on good farming practices received through mobile phones will not lead to better yields if the farmer uses bad seed. Social issues, such as women's access to the technology, must also be considered.

Mobile technology to get climate-smart agricultural information to/from farmers

There is great potential for mobile information services to push information on climate-smart agriculture to farmers and other actors in the agricultural value chain. The ability to collect large amounts of sensor data (e.g. remote soil sensors) with mobile technology has the potential to provide information that leads to new climate-smart solutions.

Mobile technology creates the opportunity for farmers to become data collectors at a local level. This makes it possible to obtain real time feedback and spot trends such as the movement of pests, which could in turn be used to alert other farmers. Before this can succeed in scale, correct incentives for farmers' participation need to be identified. Incentives could include the use of toll free SMS numbers, access to privileged information, heightened perceived status, gains in mobile talk-time for reliable contributions, among others.

Information you can act on – learning from the healthcare field

To use an example from a different industry, the Grameen Foundation launched the Mobile Technology for Community Health (MoTeCH) initiative in Ghana to improve the quality of antenatal and neonatal care in rural areas. Pregnant women registered with the service by providing their mobile number, area where they lived, estimated due date and language preference.

The system then sent relevant and actionable information via SMS or Voice messages at each stage of the pregnancy and infant's development. Vaccination reminders were also sent along with the location of the closest health facility. The program was about providing the right information at the right time to guide the mothers. In the process it was also able to collect valuable data regarding birth rates, infant health conditions and immunization. The same approach can be used in sustainable agriculture to guide the farmers at each stage of the growing cycle.

Eric Seuret, Syngenta Foundation

An example of local data collection and sharing is the CELAC (Collecting and Exchange Local Agricultural Content) project in Uganda. Launched in 2003 by the NGO Busoga Rural Open Source Development Initiative (BROSDI), the project employs ICT to map and share agricultural knowledge across the local farmers' communities. A mix of ICT including mobile phones, web portal services (audio blogs) and rural radios are used. In addition, assistance to local farmers is provided, thus strengthening the linkages between community and NGO and partially providing a reward for participation.

Other information dissemination for climate-smart agriculture includes weather related information sent out via mobile phone to farmers. Working examples can be found in the Kenya Farmer's Helpline, Nokia Life Tools, and Reuters Market Light. However, the collection and dissemination of locally useful weather data remains a challenge for several reasons. On the data supply side, in many areas meteorological services do not collect and deliver the data in a timely manner, or the data is not granular (detailed to a local level) enough. On the delivery side, information services may not have sufficient information on their clients' location or lack a delivery system that can localize the information delivered sufficiently.

The International Fertilizer Development Center (IFDC), Croplife Africa Middle East and Croplife Uganda are jointly piloting a program in Uganda to test procedures designed to eliminate counterfeit crop protection products. The pilot is utilizing a Mobile Authentication Service linked to unique product identification codes displayed on a scratch and send label (a system similar to pre-paid mobile phone refill cards).

Integrated information systems are important, so that multiple agencies (particularly public agencies) have access to the same information on similar platforms. Modern ICT has increased the operability and user-friendliness of integrated information systems, which can benefit a public sector facing large financial and human capital constraints.

While packaging and disseminating data is easier now, collecting or finding reliable, timely sources of data to provide information resources via mobile applications remains a major challenge. This has been observed across all information types, not just weather data as mentioned above. The transformation of data collected through remote sensing into farmer-accessible and actionable information is a particular challenge.

The use of mobile technology comes with limitations. SMS, while often inexpensive and easy to use, is not suitable for complex or extensive information. Voice message can circumvent literacy issues. Multi-media messages (MMS), which allow pictures, are useful but expensive and require higher-end phones. In some rural locations mobile network coverage is still unreliable. In such cases, radio can be particularly helpful in raising awareness of information services.

Generally speaking, a mix of technologies for different communication channels may be needed. The correct mix will vary by location, and the technologies available and favored by local consumers. Private sector integration is also important for this reason.

A final point – mobile technology can not only provide information solutions for climate-smart agriculture, it can also reduce travel required for information acquisition, thereby contributing to the reduction of greenhouse gas emissions.

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ICT Tools for Climate Adaptation and Risk Management

While sufficient information is generally available to large-scale growers in developed markets, providing early warning systems to mitigate risks (such as variable weather, pests and diseases, price volatility, etc.) for smallholder farmers in a highly fragmented environment remains a challenge.

Weather and pest information are often the focus of risk-mitigating information systems. These information types pair well with market information, and represent an opportunity for service providers. Reuters Market Light is an example of a mobile information service that provides both risk-mitigating and market information services.

The growing penetration of mobile phones in rural areas allows more farmers to receive real-time or near-time early warning information. The ability to specify local needs increases the usability and impact of information, something that was not possible in the past with mass media. On the other hand, profiling farmers in order to target their local needs can be very time consuming.

Effectiveness will increase with specificity and relevance. Hyper-local, actionable information is a goal.

> *An initiative by the Government of Turkey that provided higher granularity of weather and pest information resulted in a dramatic reduction in farming costs and in some cases a 50% reduction in pesticide use.*
> ICT in Agriculture Sourcebook

Curt Carnemark / World Bank

Examples exist of these local services growing beyond the pilot stage. In India, e-Choupal serves more than 4 million farmers, Reuters Market Light more than 2 million, and IFFCO Kisan Sanchar Limited (IKSL) around 5 million. Esoko's market is fast growing in Africa.

ICT could be used to minimize the risks of farming activities by increasing small farmers' access to insurance companies. Insuring against adversity, such as the impact of climate change, could boost farming in developing countries where many operators are afraid of weather susceptibility and hesitate to invest in farming.

Remote sensing is very promising in this regard. Satellite imagery has been evolving to allow for more micro-level analysis for insurance purposes, but these products are still largely unattractive for small individual farmers. Satellite imagery provides a solution to many weather data issues surrounding index-based products. Normalized Difference Vegetation Index (NDVI) is one of the best-known methods, using data available from both satellites and field sensors. Products for livestock insurance (pasture index) that use NDVI have been tested in Spain and Mexico and are now being developed in Uruguay and Argentina with World Bank support. NDVI can also be used to analyze crop growth and accurate fertilizer requirements.

> *The NDVI, which is calculated with measurements of reflected light from the red and near-infrared bands, has long been used as an indirect measure of crop yield...*
> *The combination of the adequate agronomical practice and the use of optical sensors can as such increase resource use efficiency. NDVI sensors are increasingly used in the precision agriculture for the site specific estimation of nitrogen fertilizer requirements.*
> Ortiz, R. et al. (2008)

Field sensors have great potential here once the cost of the technology decreases further. However, more work is needed to calibrate these to in-situ monitoring, and expertise in data interpretation is required.

Overall, serious challenges remain in packing a set of information that brings full value to the farmer as an information user, including the need for the various information providers and holders to collaborate.

Thanks goes to everyone who participated in this forum and made it a success. Special recognition goes to the Subject Matter Experts who volunteered their time, shared their knowledge on these important issues, and guided the discussion that lead to the output you are now reading: Bruce Campbell, CGIAR; Marjory-Ann Bromhead, World Bank; Ademola Braimoh, World Bank; Rodomiro Ortiz, Swedish University of Agricultural Sciences; Elizabeth Dodsworth, CABI; Eric Seuret, Syngenta Foundation; and, Reuben Sessa, FAO.

Applications/Resources:

Applications	Where	Description
Agro-meteorology for managing climate risk	Mali	Mali's national meteorological service launched a pilot project in 1982 to provide climate information to rural people, especially farmers. The project was the first in Africa to supply climate-related information directly to farmers, as well as to help them measure climate variables themselves, so that they could incorporate it into their decision making. *http://climatefocus.com/downloads/Agriculture%20and%20Climate%20Change%20Scoping%20Report%2012%20July%202011.pdf*
Analogue sites		It is an internet-based application coupled with GIS that provides support to the process of decision-making and evaluation of adaptation options. With a click on the computer on your site/landscape of interest you can find "analogue sites", sites you can visit to get some idea of the future climate and farming systems that may be relevant to your site. Read more about it here: *http://blogs.nature.com/news/2011/12/agricultural_time_travel_adapt.html*
appsforfarming		A smart phone app (ios/android) that allows farmers and crop advisors to record field data, share this data and send advice with the app. It was launched in the Netherlands in April 2012 in English. *http://youtu.be/rqLVW8gAliY*
Banglalink Krishi Jigyasha 7676	Bangladesh	Krishi Jigyasha 7676 was launched by Katalyst and Banglalink, the second largest mobile phone operator in Bangladesh, in 2009. The service is a SME helpline that provides information and advisory services across 67 sub-topics to farmers. It now has more than a million phone calls and other telecom service providers are considering launching a similar service. *http://www.banglalinkgsm.com/docs.php?id=16#7676*
Collecting and Exchange Local Agricultural Content (CELAC)	Uganda	Launched by the Ugandan NGO Busoga Rural Open Source Development Initiative (BROSDI) in 2003, it employs ICTs to map and share agricultural knowledge across the local farmers' communities: mobile phones, web portal services (including audio blogs) and rural radios are used in combination. In addition, assistance to local farmers is provided, thus strengthening the linkages between community and NGO. One of the activities implemented by CELAC since 2005 is a weekly information bulletin (in English and Luganda languages) sent to farmers via SMS. Information and data on various topics (e.g. pest management, best agronomic practices, crop calendar reminders) is disseminated, including some weather-related information.
Database for soil carbon sequestration		Developed by the Agriculture and Rural Development Department at the World Bank. *http://www-esd.worldbank.org/SoilCarbonSequestration/*

Applications	Where	Description
Digital Green	India	Digital Green takes a human approach to the use of modern technology in order to build capacity in farmers. Information is captured through video production that is driven by a participatory process. http://www.digitalgreen.org/
eXtension Initiative	USA	ICT-enabled systems that transform extension services and the way in which farmers access agricultural knowledge and technology. http://www.extension.org/
ECAMIC project	Ghana	IICD works with SEND Foundation in Ghana and 48 farmer organisations (around 15000 farmers). Price information collected at the local district markets is combined with other relevant agriculture information at the ECAMIC office and distributed to district offices through email. Cooperative Information Officers in these district offices used motorcycles in the past to distribute the information to the farmer communities. More and more farmers are now using mobile phones to receive SMS alerts of district market prices. The ECAMIC project uses the Esoko platform, a trading platform using internet and mobile phones. This platform is also used to send offers on produce.
Fertilizer Recommendation Solution (FRS), e-Krishok	Bangladesh	Developed in Bangladesh by SRDI, Ministry of Agriculture with support from Katalyst and promoted by BIID as a service of the e-Krishok program. The FRS system is a web-based solution to guide the farmers on correct doses and types of fertilizers for the specific location and crop.
FruTIC	Argentina	Developed by the Trace Foundation in Argentina, FruTIC provides guidance for Integrated Pest Management (IPM) to farmers. The FruTIC system captures phenological data of different crops, the presence of pests and diseases (territorially distributed sampling sites) and data from weather stations. With these data, models are run on the impact of pests and diseases, and recommendations are delivered to farmers. http://www.frutic.org.ar/
GreenSeeker	USA	Optical sensors that measure crop status and variability in their nitrogen requirements. Yield potential for a crop is identified using NDVI and other environmental factors. Nitrogen is recommended according to yield potential and the responsiveness of the crop to additional nitrogen. http://magissues.farmprogress.com/TFS/FS07Jul08/tfs011.pdf
How fresh is your fish?		An iOS app that enables the user to evaluate the freshness of fish. www.imares.wur.nl/UK/newsagenda/news/iphoneapp022012_.htm
iCow	Kenya	This is a tool to improve the control of the gestation period of cows. The farmers subscribe by text (being charged a fee) and give the details of the gestation cycle of their cow. In exchange, the farmers get a reminder when their cow is in their fertile days or when to stop milking when the cow is close to full-term. http://icow.co.ke/
ICTs along the Agriculture Value Chain		Database of ICTs for use in agricultural value chains. http://agriculture.gbiportal.net/icts-along-the-ag-value-chain/
IFFCO Kisan Sanchar (IKSL)	India	A joint venture of Indian Farmers Fertilizer Cooperative Limited (IFFCO) and Bharti Airtel, providing content and services to famers in India. http://www.iksl.in
Index-based livestock insurance (IBLI)	Kenya	Winner of the V2030 ICT Innovation Award from the Kenya ICT Board, IBLI provides compensation to insured pastoralists in the event of livestock losses due to severe forage scarcity and incorporates remotely-sensed vegetation data in its design, which is delivered through mobile ICT-based transactions platforms. http://livestockinsurance.wordpress.com
KenCall	Kenya	Weather information is provided to farmers through mobile phones. http://www.kencall.com/
Kenyan Agriculture Commodity Exchange (KACE)	Kenya	In collaboration with the mobile phone provider Safaricam, this is a service through which farmers can request the market price for a range of crops. They have to pay for the SMS message plus a small fee (Total fee = 7Ksh = .10 USD). http://www.kacekenya.co.ke/

Applications	Where	Description
Kilimo Salama ("Safe Agriculture")	Kenya	A micro-insurance program using mobile phones designed for Kenyan farmers. The project is a partnership between Syngenta Foundation of Sustainable Agriculture, UAP Insurance, and telecoms operator Safaricom. *http://kilimosalama.wordpress.com*
Local data collection and climate change research		Canessa and Zennaro, 2010: M-Science: Sensing, Computing, and Dissemination *http://sdu.ictp.it/m-science/mScience_small.pdf* Dillon, 2010: Research on Expectations about Agricultural Production *http://www.edi-africa.com/docs/Dillon_MobilePhoneSurveys.pdf* Ortiz, R. et al. (2008) Climate change: can wheat beat the heat? Agriculture, Ecosystems 126, 45-58. doi:10.1016/j.agee.2008.01.019
Mitigation of Climate Change in Agriculture (MICCA)		Launched in 2010, MICCA is a multidisciplinary programme working to make agriculture climate-smart. *http://www.fao.org/climatechange/micca/75369/en/*
OPPAZ organic certification using smartphones	Zambia	The Zambian farmers' association OPPAZ has successfully introduced ICT to increase efficiency of certification processes. Over 10,000 organic farmers throughout Zambia participate in a programme that uses a digital collection system for organic certification through the use of smartphones. The introduction of ICT has resulted in a 30% decrease in costs and time of national and international certification for participating producers. It has also resulted in a 20% increase in membership of new producers, now able to finance the certification process and gain access to premium prices in the market for organic products. *http://www.oppaz.org.zm/*
Nano Ganesh	India	Control of irrigation and water resources by mobile technology. *http://agriculture.gbiportal.net/2011/11/21/nano-ganesh-a-mobile-app-for-remote-irrigation-control/*
Nutrient Manager for Rice Mobile (NMRiceMobile)	Philippines	Designed to give fertilizer guidelines to rice farmers via their mobile phones (smartphones with Android operating systems), and complimentary to web application NMRice. *http://irri.org/news-events/media-releases/feeding-rice-just-got-easier-with-smartphones*
OneFarm	India	A service provided by Ekgaon (India) that provides customized package of crop management information for farmers in Tamil Nadu, Gujarat and Rajasthan. Started in 2009, 12,000 now farmers subscribe to the service, with plans to have 5 million subscribers by 2016. *http://www.ekgaon.com/home*
Pinoy Farmer Internet Project	Philippines	An internet based extension support service that began in 2003 with support from a multi-agency partnership. *http://pinoyfarmer.wordpress.com/*
Progis	Germany	ICT solutions for agriculture forestry, environment and risk-management. Products include WinGIS for land parcel systems, DokuPlant for advisory services, and mobGIS for logistics. *http://www.progis.com/en/*
The Role of ICT for Community-Based Adaptation to Climate Change		An overview on the application of communication and ICTs for community-based livelihood adaptation to climate change. *http://www.csdinitiative.org/view-document-details/31-the-role-of-information-and-communication-technologies-for-community-based-adaptation-to-climate-cha.html*
Solar phone chargers	Ghana	Responding to the challenges that famers have when there is no electricity in their villages, IICD piloted small solar chargers to find out if that would be a robust working solution. It was and now they provide 200 solar chargers for a subsidized amount to the different farmer groups. *http://www.iicd.org/articles/ghanaian-farmers-use-solar-chargers-for-their-phones*