SECTION 1

Overview of ICT in Agriculture: Opportunities, Access, and Cross-Cutting Themes

Module 1: INTRODUCTION: ICT IN AGRICULTURAL DEVELOPMENT

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INFORMATION AND COMMUNICATION TECHNOLOGY: FINDING A PLACE IN THE AGRICULTURE SECTOR

Information and communication have always mattered in agriculture. Ever since people have grown crops, raised livestock, and caught fish, they have sought information from one another. What is the most effective planting strategy on steep slopes? Where can I buy the improved seed or feed this year? How can I acquire a land title? Who is paying the highest price at the market? How can I participate in the government's credit program? Producers rarely find it easy to obtain answers to such questions, even if similar ones arise season after season. Farmers in a village may have planted the "same" crop for centuries, but over time, weather patterns and soil conditions change and epidemics of pests and diseases come and go. Updated information allows the farmers to cope with and even benefit from these changes. Providing such knowledge can be challenging, however, because the highly localized nature of agriculture means that information must be tailored specifically to distinct conditions.

Agriculture is facing new and severe challenges in its own right (see box 1.1). With rising food prices that have pushed over 40 million people into poverty since 2010, more effective interventions are essential in agriculture (World Bank 2011). The growing global population, expected to hit 9 billion by 2050, has heightened the demand for food and placed pressure on already-fragile resources. Feeding that population will require a 70 percent increase in food production (FAO 2009).

Filling the stomachs of the growing population is only one reason agriculture is critical to global stability and development. It is also critical because one of the most effective ways of reducing poverty is to invest in and make improvements in the agricultural sector. Even after years of industrialization and growth in services, agriculture still accounts for one-third of the gross domestic products (GDP) and three-quarters of employment in sub-Saharan Africa. Over 40 percent of the labor force in countries with per capita incomes in the US$ 400 to 1,800 range works in agriculture (World Bank 2008). Because agriculture accounts for the vast majority of the poor's livelihood activities, it is also the sector that holds the most promise for pro-poor economic growth. In fact, agriculture is around four times more effective at raising incomes among the poor than other sectors (World Bank 2008). No less important, improved agriculture also has a direct impact on hunger and malnutrition, decreasing the occurrences of famine, child stunting, and maternal infirmity.

Given the challenges, the arrival of information communication technology (ICT) is well timed. The benefits of the green revolution greatly improved agricultural productivity. However, there is a demonstrable need for a new revolution that will bring lower prices for consumers (through reduced waste and more-efficient supply chain management), contribute to "smart" agriculture, and incentivize farmers (for example, through higher income) to increase their production. Public and private sector actors have long been on the search for effective solutions to address both the long- and short-term challenges in agriculture, including how to answer the abundant information needs of farmers. ICT is one of these solutions, and has recently unleashed incredible potential to improve agriculture in developing countries specifically. Technology has taken an enormous leap beyond the costly, bulky, energy-consuming equipment once available to the very few to store and analyze agricultural and scientific data. With the booming mobile, wireless, and Internet industries, ICT has found a foothold even in poor smallholder farms and in their activities. The ability of ICTs to bring refreshed momentum to agriculture appears even more compelling in light of rising investments in agricultural research, the private sector's strong interest in the development and spread of ICTs, and the upsurge of organizations committed to the agricultural development agenda.

But what exactly are ICTs? And can they really be useful and cost-effective for poor farmers with restricted access to capital, electricity, and infrastructure? First, an ICT is any device, tool, or application that permits the exchange or collection of data through interaction or transmission. ICT is an umbrella term that includes anything ranging from radio to satellite imagery to mobile phones or electronic money transfers. Second, these ICTs and others have gained traction even in impoverished regions. The increases in their affordability,

accessibility, and adaptability have resulted in their use even within rural homesteads relying on agriculture. New, small devices (such as multifunctional mobile phones and nanotechnology for food safety), infrastructure (such as mobile telecommunications networks and cloud computing facilities), and especially applications (for example, that transfer money or track an item moving through a global supply chain) have proliferated. Many of the questions asked by farmers (including questions on how to increase yields, access markets, and adapt to weather conditions) can now be answered faster, with greater ease, and increased accuracy. Many of the questions can also be answered with a dialogue—where farmers, experts, and government can select best solutions based on a diverse set of expertise and experience.

The types of ICT-enabled services that are useful to improving the capacity and livelihoods of poor smallholders are growing quickly. One of the best examples of these services

BOX 1.1: Globalizing Food Markets and New Challenges for Smallholder Farmers

Understanding and addressing global agriculture developments—both advantageous and not—are critical to improving smallholder livelihoods, in which ICT can play a major role. The continued increase in globalization and integration of food markets has intensified competition and efficacy in the agriculture sector, and has brought unique opportunities to include more smallholders into supply chains. Yet in the same vein, agriculture faces a range of modern and serious challenges, particularly in developing countries exposed to price shocks, climate change, and continued deficiencies in infrastructure in rural areas.

When commodity prices rise quickly and steeply, they precipitate concerns about food insecurity, widespread poverty, and conflict—more so in countries that import high volumes of staple foods. Globalized food markets also increase the risk that some countries and many smallholders will remain marginalized from the expanding and more profitable agricultural value chains (such as premium foods, which have seen an increase in demand due to an expanding middle class) that rely on technical sophistication to ensure speed, scale, and customization.

Climate change has also played an acute role in keeping smallholders in the underbelly of value chains. Farmers can no longer rely on timeworn coping strategies when all of their familiar benchmarks for making agricultural decisions—the timing of rains for planting and pasture, the probability of frost, the duration of dry intervals that spare crops from disease—are increasingly less reliable. Severe and unexpected weather are shrinking already-limited yields and promoting migration from rural areas and rural jobs. Weather-related events leave developing-country governments, who lack the resources and the private sector investment to provide risk management instruments, to cope with major crop failures and the displaced victims only after the fact.

It is in the context of globalizing agriculture where the need for information becomes most vivid. The smallholders, who still provide a significant portion of the world's food, need information to advance their work just as much as industrial-scale producers. Comparing the two types of farmers—industrial and small-scale—exemplifies the latter's disadvantages. Where wealthier industrial producers can use the Internet, phone, weather forecasts, other digital tools, and technologies as simple as vehicles and infrastructure as basic as electricity to glean information on prices, markets, varieties, production techniques, services, storage, or processing, smallholders remain dependent primarily on word of mouth, previous experience, and local leadership.

The smallholder disadvantage does not stop there. Financial and insurance services are often out of reach and poorly understood. Key intermediaries like producer organizations and rural institutions (including local government) could help alleviate the disadvantage, but in many places, the former are just emerging and the latter are inefficient and nontransparent. Both require a variety of technical and financial support to grow and become inclusive and effective. Many of these challenges and others can be addressed by using ICT effectively.

Source: Authors.

IMAGE 1.1: Soil Data Can Be Collected and Disseminated by a Variety of ICT

Source: Neil Palmer, CIAT.

is the use of mobile phones as a platform for exchanging information through short messaging services (SMS). Reuters Market Light, for example, services over 200,000 smallholder subscribers in 10 different states in India for a cost of US$ 1.50 per month. The farmers receive four to five messages per day on prices, commodities, and advisory services from a database with information on 150 crops and more than 1,000 markets. Preliminary evidence suggests that collectively, the service may have generated US$ 2–3 billion in income for farmers (Mehra 2010), while over 50 percent of them have reduced their spending on agriculture inputs[1].

ICT-enabled services often use multiple technologies to provide information (image 1.1). This model is being used to provide rural farmers localized (non-urban) forecasts so that they can prepare for weather-related events. In resource-constrained environments especially, providers use satellites or remote sensors (to gather temperature data), Internet (to store large amounts of data), and mobile phones (to disseminate temperature information to remote farmers cheaply)—to prevent crop losses and mitigate effects from natural adversities.

Other, more-specialized applications, such as software used for supply chain or financial management are also becoming more relevant in smallholder farming. Simple accounting software has allowed cooperatives to manage production, aggregation, and sales with increased accuracy. The Malian Coprokazan, involved in shea butter production, began using solar-powered computers with keyboards adapted to the local language to file members' records electronically. Along with electronic administration, the coop plans to invest in Global Positioning System (GPS) technology to obtain certifications and use cameras and video as training materials to raise the quality of production. From 2006 to 2010 alone, the coop's membership grew from 400 to 1,000 producers (http://www.coprokazan.org/).

These examples represent only a minute subset of the information and communication services that can be provided to the agricultural sector through increasingly affordable and accessible ICTs. Hundreds of agriculture-specific applications are now emerging and are showing great promise for smallholders, as illustrated in the more than 200 project-based case studies and examples in this Sourcebook. In order to exploit the possibilities, countries have two tasks:

(A) To empower poor farmers with information and communication assets and services that will increase their productivity and incomes as well as protect their food security and livelihoods, and

(B) to harness ICTs effectively to compete in complex, rapidly changing global markets (avoiding falling behind the technology curve).

Accomplishing these tasks requires the implementation of a complex set of policy, investment, innovation, and capacity-building measures, in concert with beneficiaries and other partners, which will encourage the growth of locally appropriate, affordable, and sustainable ICT infrastructure, tools, applications, and services for the rural economy.

1 See Topic Note 9.4 in Module 9.

Importantly, ICT is not an end to agricultural development. The excitement generated by ICTs as they spread throughout developing countries has often masked the fact that their contributions to agriculture are both rapidly evolving and poorly understood. It is too early to have a clear idea, supported by rigorous analysis, of how ICTs support agricultural development, and under what conditions. While there is credible evidence of positive impact, questions remain about how to make these innovations replicable, scalable, and sustainable for a larger and more diverse population. A central goal of this Sourcebook is to analyze and disseminate evidence of the impact of ICTs on agricultural development and rural poverty reduction, exploring opportunities for long-term and expansive efforts.

THE WAY FORWARD: UNDERSTANDING THE WHY AND THE HOW

Each module in the Sourcebook discusses the key challenges, enablers, and lessons related to using ICTs in a specific subsector of agriculture. These are derived from a range of experiences, and summarize the knowledge gained during pilot projects and wider initiatives. While different in type of intervention and approach, a string of themes emerges from the modules. These themes—namely the why and how of using ICT in agricultural development—demonstrate the great potential of ICT and help to clarify the way forward.

The Why: Drivers of ICT in Agriculture

Five main trends have been the key drivers of the use of ICT in agriculture, particularly for poor producers: (1) low-cost and pervasive connectivity, (2) adaptable and more affordable tools, (3) advances in data storage and exchange, (4) innovative business models and partnerships, and (5) the democratization of information, including the open access movement and social media. These drivers are expected to continue shaping the prospects for using ICT effectively in developing-country agriculture.

Low-Cost and Pervasive Connectivity

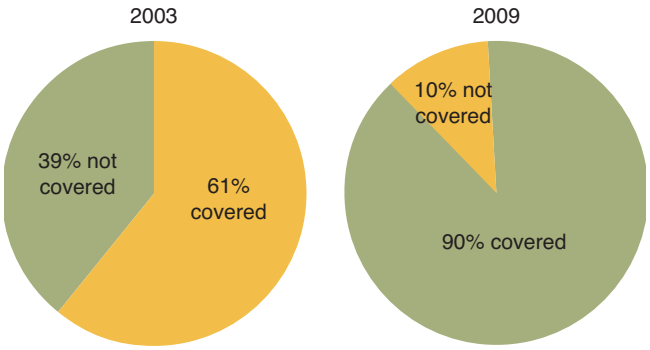
The pervasiveness of connectivity—to mobile phones, Internet, and other wireless devices—is due to a number of factors, including decreases in costs, increases in competition, and expansion of last-mile infrastructure. Several trends, working in tandem, are making ICT devices and services more affordable in ways that also extend access to small-scale producers.

Mobile phones are in the vanguard of ICTs in agriculture. By the end of 2011, over 6 billion mobile phone subscriptions—or more accurately, subscriber identity module (SIM) cards—are expected to be in use worldwide (Wireless Intelligence 2011). Mobile phone penetration in the developing world now exceeds two subscriptions for every three people, driven by expanding networks in Asia and in Africa. The ability to purchase a low-cost mobile phone is complemented by the expansion in telecommunications infrastructure; most countries now have more than 90 percent of their population served by a cell phone signal, including coverage in rural areas (see figure 1.1). This rapid expansion results from enabling regulations that ensure competition in the telecommunications sector as well as from high demand for mobile phone subscriptions.

The reach and affordability of broadband Internet is also improving dramatically—though somewhat slower—in developing regions. In 2010, the number of Internet users surpassed 2 billion and over half of these users are now in developing countries. Internet connectivity around the world has grown exponentially since 2000, by over 480 percent (Internet World Statistics, 2011).The price of bandwidth has continued to drop as well, driving down the costs of extending connections to isolated communities. In sub-Saharan Africa, which lags other regions in ICT accessibility, a recent surge of investments in international undersea cables and inland infrastructure to complete those connections is making ICTs services substantially more accessible and affordable across Africa (figure 1.2). By 2010, 12.3 terabits per second of backbone capacity was operational in Africa, up from less than 1 gigabit per second at the start of the decade (TeleGeography 2011).

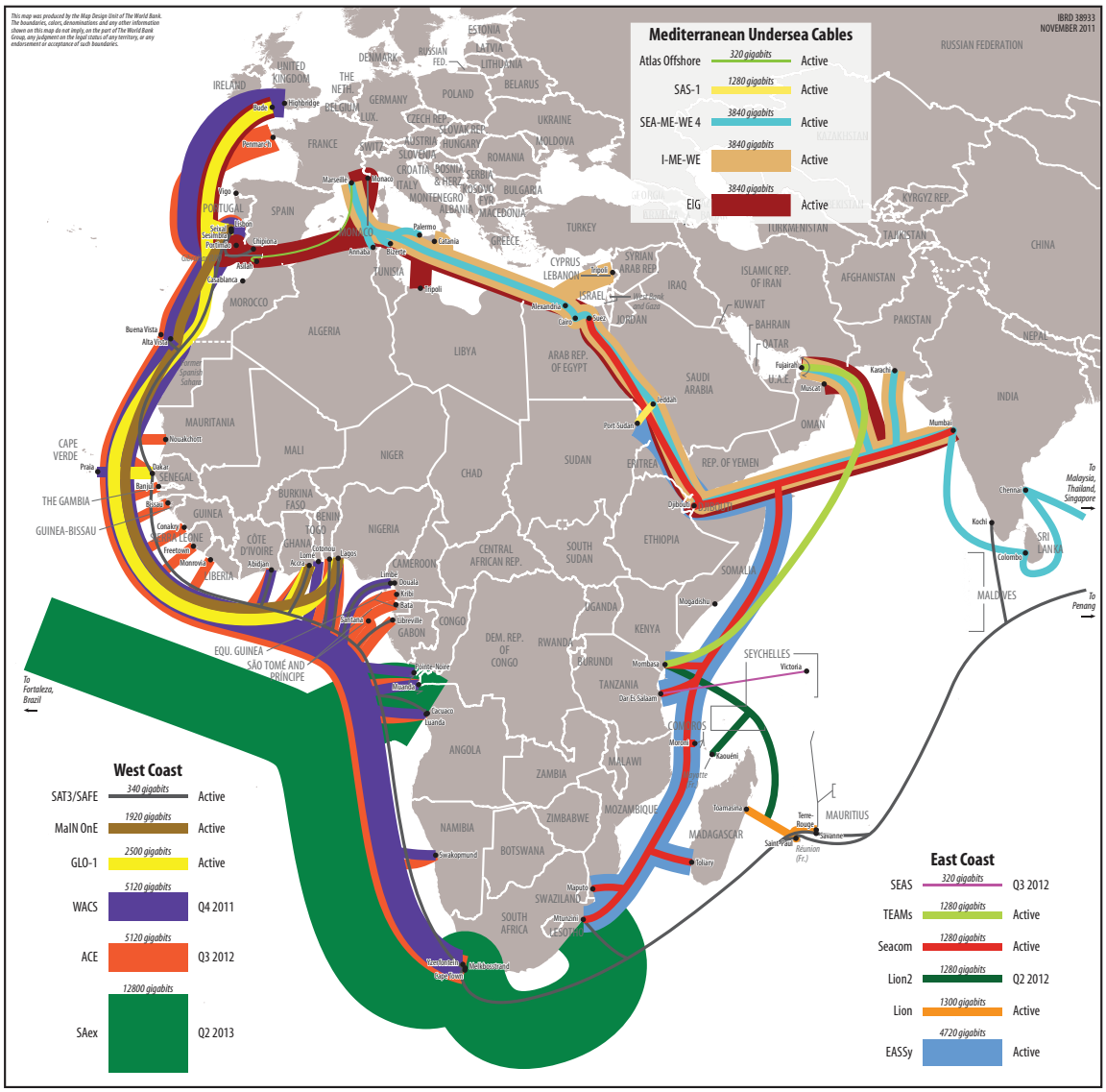
Telecenters or other community-based facilities can provide Internet access in locations where broadband is too expensive

FIGURE 1.1: Percentage of the World's Population Covered by a Mobile Cellular Signal



Source: International Telecommunications Union.

FIGURE 1.2: African Undersea Cables, Those Working and Those in Development



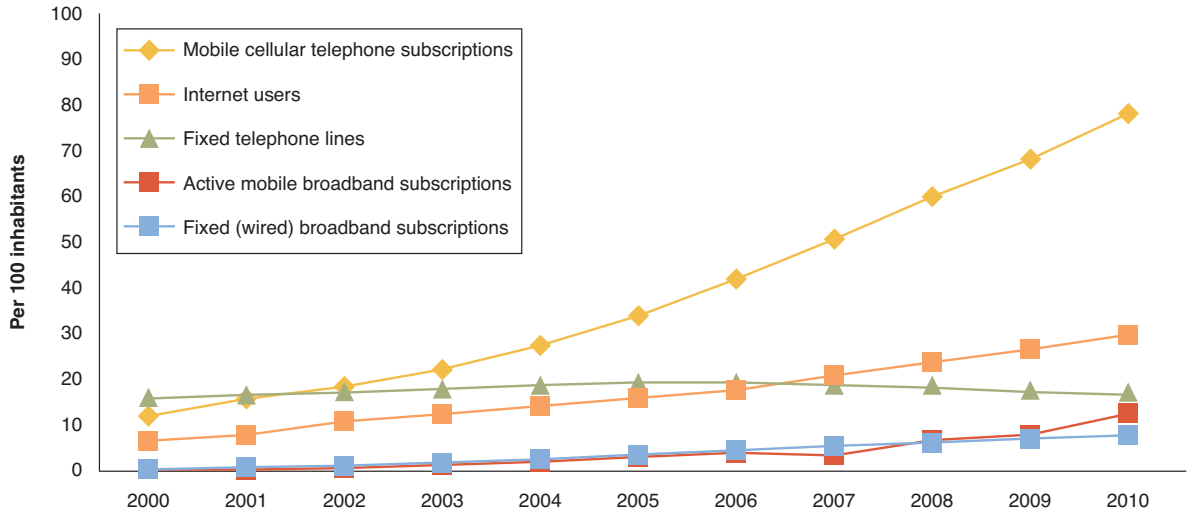
Source: Adapted from Steve Song, http://manypossibilities.net and TeleGeography.

for individuals to use on their own. Internet access is also expected to increase through the continued rollout of third- and fourth-generation (3G and 4G) mobile networks that greatly improved capacity for carrying data. Smartphones, such as BlackBerries or iPhones, which include 3G mobile services with remote Internet connection, will increase access to information even to poor farmers. The International Telecommunication Union (2010) reports that at the end of 2010, 143 countries offered commercial 3G services, providing at least 256 kilobits per second of bandwidth and supplying voice and data simultaneously (figure 1.3 shows the slow, but increasing rate of uptake of mobile broadband) and other ICT tools.

Adaptable and More Affordable Tools

The proliferation of adaptable and more affordable technologies and devices has also increased ICT's relevance to smallholder agriculture. Innovation has steadily reduced the purchase price of phones, laptops, scientific instruments, and specialized software. Agricultural innovation in developed countries has become more applicable to developing-country needs. The intuitive design of many technologies and their capacity to convey information visually or audibly make them useful to people with limited formal education or exposure to technology.

FIGURE 1.3: Global ICT Development from 2000–2010



Source: International Telecommunications Union's World Telecommunication/ICT Indicators database.

Mobile-based applications are also becoming more suitable for poor and isolated communities, especially though feature phones. Drawing on simple, available technologies such as SMS, service providers can offer mobile banking, other transactional services (selling inputs, for example), and information services (market price alerts). Other publicly and privately provided services such as extension and advisory services are delivered over mobiles, which are increasingly not just "phones" but are actually multifunctional wireless devices.

Geospatial information is also becoming easier to access and use as mapping tools, such as Microsoft Earth or Google Maps (image 1.2), bring geographical data information to nonspecialist users. Scientists and development organizations have created substantial sets of georeferenced data on population, poverty, transportation, and any number of other public goods and variables through more affordable, usable geographic information systems available on standard PCs and mobile devices using web-based tools. Satellite images and similar representations have improved exponentially in quality and detail. These tools and remote sensors use less energy and require less human attention than in previous years. The capacity to overlay geospatial information with climate and socioeconomic data opens many options for analyzing biophysical trends (such as erosion or the movement of pathogens), making projections (about the effects of climate change or the best location of wholesale markets in relation to transport infrastructure), and selecting particular groups to test new technologies or farming practices (for instance, identifying farmers that are most likely to benefit from using e-vouchers to purchase fertilizer).

Advances in Data Storage and Exchange

Greatly increased data storage capacity and the ability to access data remotely and share it easily have improved the use of ICT in agriculture. Sharing knowledge and exchanging data have created opportunities to involve more stakeholders in agricultural research—involvement facilitated by an

IMAGE 1.2: Google Map of Kampala, Uganda.

Source: Google Maps.

improved e-learning environment and networking capacity. Advances in data storage and sharing have improved the ability to exchange information—for instance, between departments and levels of government—and avoid costs associated with data transmission charges.

Improvements in data storage and sharing have underlying causes. The capacity of hard drives and the speed of microprocessors have continued to rise, making it dramatically cheaper to store data. Cloud computing offers access to numerous shared computing resources through the Internet, including sharable tools, applications, and intelligently linked content and data. These advances address some of the information and communication constraints of agricultural research institutions, government offices, cooperatives, and development organizations. Benefits of enhanced data capacity range from more accurate targeting of agricultural development programs to better preparation for handling surpluses or scarcities at the farm level.

New Business Models and Public-Private Partnerships

The development and use of many ICTs originated in the public sector but were quickly dominated by the private sector when their profit potential became clear. The public sector maintains great interest in ICT as a means of providing better public services that affect agriculture (for instance, land registration, forest management, and agricultural extension services), as well as for connecting with citizens and managing internal affairs. Private sector involvement in some of these efforts has enhanced the access, affordability, and adaptability of ICTs for development. Unlike other development strategies, which often struggle to survive or be scaled because the public sector cannot fund them, development strategies featuring ICTs have benefited from growing private sector interest and public demand (image 1.3).

The entrepreneurial nature of ICTs attracts new partnerships and forms of investment. Mobile phone applications, software design, local language customization, and remote transaction services represent only a fraction of the opportunities for continued innovation. Private companies that have invested in technology and applications are often interested in working with the public sector to provide their products and services to smallholders. Mobile network operators, for example, can invest by providing large text packages at a lower price, collecting premiums, distributing payments, or participating in extending networks to rural areas. Commercial enterprises such as processors, input suppliers, and exporters are also motivated to invest in ICT because they often lead to increased efficiency and revenue as well as extensions to client bases like isolated farmers.

New forms of business incubation and knowledge brokering are also contributing to ICT in agriculture. The private sector has a keen interest in investing in firms that come out of such incubation schemes, speculating on the ability of an innovative idea to expand into a highly profitable enterprise. Incubators identify additional investors and other suitable partners, including technical experts. In many instances, they develop enterprises through which private and public providers of agricultural services collaborate to deliver products more efficiently to farmers; in developing, sharing, and capitalizing on innovations for agricultural development, they almost always use ICT and often develop new ICT tools.

IMAGE 1.3: Public-Private Partnerships Often Lead to More-Sustainable Services for Rural People

Source: Nokia.

Knowledge brokering, in which a private enterprise provides information for a fee (for example, farmers obtain market, price, crop, and weather information via their mobile phones), is also gaining traction. This business model reduces the burden on the public sector while increasing the abilities of brokers and farmers to profit from information sharing.

Democratization of Information, the Open Access Movement, and Social Media

The democratization of information and science facilitated by ICTs is also contributing to agriculture and rural development more broadly. Vast quantities of information held by institutions and individuals are becoming visible, publicly accessible, and reusable through the open access movement. Many governments and organizations such as the World Bank, the

Food and Agriculture Organization, the Consultative Group on International Agricultural Research are aiming to make data—like national surveys or research findings—publicly available. These actions have not only improved transparency and accountability but have invited the public, private, and research sectors to participate in solving long-term economic and social problems, including those involving agriculture.

The expansion of open access software also enables grassroots community organizations to share knowledge with one another. Social media, once used purely for entertainment, has great potential to be used for knowledge sharing and collaboration even in agriculture. Although penetration of the most popular social medium, Facebook, was estimated at just 3 percent in Africa and almost 4 percent in Asia in 2010, compared to 10.3 percent (over half a billion users) globally (Internet World Statistics, 2011), recent geopolitical events highlight the effectiveness of social media for sharing information and motivating collective action—two key features of agriculture development.

Finally, crowdsourcing, in which scientists, governments, and development organizations request feedback from farmers and consumers through devices like mobile phones, is also facilitating agriculture development. Farmers can use SMS to send critical local agricultural information like incidences of pests or crop yields that was previously difficult to obtain without expensive surveys by researchers. Using the digital tools available, consumers can also provide information related to changing consumption patterns and tastes to private enterprise.

The How: Lessons Learned So Far

A number of key lessons related to ICT-in-agriculture policies and projects were gleaned during the research for this e-sourcebook. Using ICT to achieve agricultural development goals requires supplementary investments, resources, and strategies. Flexible but strongly supportive policies and regulations, complementary investments in physical infrastructure, support to men and women farmers of different age groups, technological appropriateness, and the enabling environments for innovation and new businesses will determine the long-term impact and sustainability of these efforts. These lessons are not conclusive—much remains to be learned—but they serve as sound considerations as investments are made in future interventions.

Concentrate on the Demand, Not on the Technology

The versatility and near-constant innovation that characterize ICT can be a distraction: They can cause interventions to focus more on the technology than on the priorities of the intended clients and the tradeoffs imposed by resource-constrained environments. It is important to begin any ICT-in-agriculture intervention by focusing on the need that the intervention is purposed to address—not the need for ICT—but the need for better and more timely market information, better access to financial services, timely and appropriate crop and disease management advice, stronger links to agricultural value chains, and so forth. In some cases, ICT will not be an effective means to meet these needs at all.

Years of agricultural development experience show that projects that involve new technologies require farmers' engagement, right from the start. Interventions that make meager efforts to involve farmers in planning and design result in low uptake, trust, and interest. The same is true for programs or strategies involving ICTs for development. A weak focus on farmers' needs at the expense of ICT will ignore ancillary needs for investment in human capacity, community participation, or infrastructure.

Use Appropriate Technologies

The attractiveness of the newest ICTs can lead to a preference for the latest technologies at the expense of older technologies (such as radio), yet the newest, most elaborate, or most innovative technology is not automatically the most appropriate one. Moreover, an innovative mix of technologies (for instance, radio programs with a call-in or SMS facility for feedback) can be the most cost-effective solution. Well-reasoned assessment of the tradeoffs between the added cost of a technology or service and benefits relative to other options (technological and other) is important.

The wide coverage of mobile devices reduces but does not eliminate these tradeoffs. In considering the appropriateness of technology, assessing the human capital available for developing and disseminating the ICT device or application is critical. The more complex the technology, the more training and (qualified) extension support it will require. In environments where infrastructure is not conducive to a particular instrument, other means should be used.

Finally, it is important to recognize that these newer technologies do not automatically replace the more traditional forms of communication, knowledge sharing, and collective action

that have evolved within a given community or region. In designing ICT interventions, it is necessary to research and understand local information and communication practices, barriers to ICT-enabled empowerment, and priority information and communication needs of end users. Using conventional information and communication tools to address the needs of those who cannot access the ICT because of limitations related to literacy, isolation, and social norms is often required.

Focus on Affordable Access and Use, Not Ownership

In designing ICT-in-agriculture interventions, it is vital to bear in mind that "access" refers not only to the physical proximity and accessibility of ICT infrastructure, tools, and services but also to their affordability, use, and usage models that are appropriate for the local physical, environmental, and cultural constraints. The specific mix of individual-user and shared-use/public-access models that is most appropriate and locally sustainable will vary depending on local needs and resources, and will change over time as devices and services diversify further and become even more affordable. As the costs of ownership of ICTs have come down, the affordability and accessibility divide has improved, especially for individual user services. However, it also may be that in some cases, learning is better facilitated through shared access than individual access facilities.

Actual use of the technology should also be monitored, as a supplied technology does not necessarily imply that it is being used for economic means. Many times, mobile phones and other devices function strictly as a tool for basic communication or entertainment. This is often a result of participants' low exposure to ideas or methods on how the ICT can be used to achieve agriculture or other economic goals.

Be Aware of Differential Impacts, Including Gender and Social Differences in Access and Use

Under certain conditions, ICT interventions can worsen rather than alleviate underlying economic, social, and political inequalities, including those between women and men. Rural women, face significant disadvantages in accessing information and communication assets and services. Many of the fixed-location ICT projects designed to enhance rural access to information assets and services were or are owned or managed by men. Cultural attitudes and women's multiple roles and heavy domestic responsibilities often exclude them from these services. The same attitudes and lack of control over family income can prevent women from owning or even using phones. However, the growing availability and lower cost of mobile phones, as well as other contributing factors, has the potential to meet women's agricultural needs (image 1.4).

IMAGE 1.4: Determining Levels of Inclusiveness Is a Critical Factor in ICT Interventions

Source: Nokia.

Social access issues extend beyond gender. A full understanding of the local, national, and regional agricultural economy is important for ensuring that ICT interventions do not restrict poor producers' participation to the low end of agricultural value chains like other technologies have. ICT in itself does not guarantee full participation by all social groups. Efforts to be inclusive must focus on the full range of capacities and resources that small-scale producers will need to benefit from an intervention. Questions of social access should be raised consistently when using ICT to improve rural livelihoods. Do sociocultural norms or divisions prevent certain groups from using the technology? Will better-off groups benefit more than poor groups? Will floods of entertainment and spurious information dilute the knowledge needed for sustainable agricultural and rural development? Broad-based rural development depends on monitoring and evaluating outcomes and making adjustments along the way.

Create an Enabling Environment for Innovation in Infrastructure Investment, Business Models, Services, and Applications

Effective design and consistent, transparent implementation of appropriate policies and regulations guiding a country's investment in and provision of ICT infrastructure, tools, and

services is key to enabling ICT interventions. In creating a supportive environment for ICT innovation and service provision, effective policies and regulations in a number of other key areas are equally important, such as public and private financing of infrastructure, the business environment, support for innovation, and intellectual property. ICT-in-agriculture interventions require a strong, but flexible, regulatory environment; the policy environment is further strengthened by incentives for the private sector to make investments.

Develop Sustainable Business and Investment Models through Partnerships

Public-private partnerships are now considered essential to the long-term viability of most interventions that use ICT in agriculture. The public sector in developing countries particularly may need guidance in providing technological services; a lack of human and financial resources as well as the overwhelming needs of the agrarian population weaken its ability to provide widespread services of acceptable quality.

With private investment, public service provision can be more sustainable. Other partnerships also appear important to sustainability (image 1.5). Technical experts with experience in various subsectors; information technology (IT) teams for technological maintenance, design, and troubleshooting; multi-level policy makers; and farmers and farmers' organizations who can provide local know-how, are also often all needed in one way or another.

IMAGE 1.5: A Collaborative Effort Among Many Actors Is Important for ICT in Agriculture

Source: Neil Palmer, CIAT.

Promote Leadership and Find Champions

Last, but not certainly not least, ICT interventions require leadership. Champions are needed to push projects forward in the development agenda and make them visible and interesting to the stakeholders—farmers, businesses, and others—who need them. These leaders must operate at the national level where budgetary and strategic decisions are made. They must also operate at local levels, modeling the effective use of a technology and building farmers' trust in its efficacy. Leaders build public confidence in an intervention. Uptake is typically low if confidence in the chosen ICT and its potential impact is minimal. Leaders are needed for the long haul, as interventions that require new infrastructure or policy and institutional reforms take years to complete.

USING THIS E-SOURCEBOOK

The *ICT for Agriculture e-Sourcebook* has been developed jointly by the World Bank's Agricultural and Rural Development Sector and *info*Dev, and has benefited from generous funding from the Government of Finland under the Finland/*info*Dev/Nokia program *Creating Sustainable Businesses in the Knowledge Economy.* It is designed to support practitioners and policy makers in taking maximum advantage of the potential of ICTs as tools for improving agricultural productivity and smallholder incomes, strengthening agricultural markets and institutions, improving agricultural services, and building developing-country linkages to regional and global agricultural value chains. It focuses primarily on how ICT can assist small-scale producers and the intermediate institutions that serve them, yet it also looks at how to link smallholders to ICT-enabled improvements in larger-scale farming, markets, and agribusiness to stimulate the broader rural economy.

The Sourcebook provides users with a fairly comprehensive overview of current and upcoming ICT-in-agriculture applications and how they might improve agricultural interventions or strategies. The Sourcebook is not a primary research product nor does it claim to be the definitive treatment of a sector that is evolving so rapidly. The modules are intended to serve as a practical resource for development professionals seeking a better understanding of the opportunities and existing applications offered by ICT as tools for agricultural development.

Overall, each module seeks to provide guidance through real examples for development practitioners in the following areas:

- Providing a landscape of existing ICT applications that assesses applications in their local context.
- Understanding current trends in ICTs as they pertain to agriculture and the contributions that ICT can make to enhance agricultural strategies and their implementation.
- Designing, implementing, and evaluating appropriate and sustainable ICT components of agricultural projects.
- Building effective partnerships—public and private—to promote ICT access and innovation for agriculture.
- Including ICT in policy dialogue and planning with country counterparts on agricultural and rural development goals and priorities.

To facilitate learning, the Sourcebook is split into this introductory module plus 14 modules focusing on specific aspects of the agricultural sector in relation to ICTs (table 1.1). Each module provides:

- An overview of how ICT is used in each focus area, along with the current trends;
- The challenges, lessons, and key enablers for using ICTs;
- A number of Topic Notes that address subjects related to each focus area, pinpointing how ICTs can be used to meet specific objectives; and
- Innovative Practice Summaries and other examples that demonstrate success and failure in interventions.

In the beginning of each module, an "In this Module" Box briefly describes the content in the modules, including the overview, Topic Notes, and Innovative Practice Summaries. The Innovative Practice Summaries are bulleted underneath the description of the Topic Note, and can be viewed directly by clicking on the title. Many of the tools, examples, and projects discussed also include links to websites and other useful resources.

Due to the changing nature of ICT, the Sourcebook is provided electronically at http://www.ictinagriculture.org/. The website provides a wide array of additional resources, follows new private and public sector applications, reviews impact assessments and research, and presents updates from interventions discussed in the modules. In addition, the website maintains occasional forums and discussions, creating a space for practitioners from various disciplines to share knowledge and experiences. The online version also allows users to "build their own Sourcebook" by downloading modules relevant to their needs and linking directly from hyperlinks in the text to projects or technologies of interest in the other modules or on the web.

Over time, the World Bank and *info*Dev will continue to build collaborations with other organizations and subject matter experts to expand and update the Sourcebook as new examples, evidence, and good practices emerge. Given the still-limited evidence on how to implement ICT-in-agriculture initiatives, the World Bank plans to further develop its operational practices and country-specific technical assistance as evidence and analysis accumulates.

TABLE 1.1: Themes Treated in Sourcebook Modules

OPPORTUNITIES, ACCESS, & CROSS-CUTTING THEMES	ENHANCING PRODUCTIVITY ON THE FARM	ACCESSING MARKETS AND VALUE CHAINS	IMPROVING PUBLIC SERVICE PROVISION
Access and affordability Mobile applications Gender and ICT services	Increasing productivity Agriculture innovation systems Rural finance Farmer organizations	Market and price information Supply chain management Risk management Traceability and food safety	Rural governance Land administration Forest governance

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