Module 10: **ICT APPLICATIONS FOR SMALLHOLDER INCLUSION IN AGROBUSINESS SUPPLY CHAINS**

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**Overview.** Smallholders can raise their incomes by participating in commercial supply chains, but including smallholders entails significant challenges for agribusinesses and smallholders. For agribusinesses, interacting with a large group of smallholders implies high transaction and monitoring costs to ensure quality, safety, and timely delivery. For smallholders, participation can be risky, requiring access to inputs and training to satisfy stringent quality requirements. Information communication technologies (ICTs) facilitate exchanges and flows of information between parties all along the supply chain and can be used to manage transactions, arrange logistics, and ensure that quality specifications are clearly understood. Under the right circumstances agribusinesses have the incentives, capacity, and resources to create and apply technologies that support inclusion. Public organizations play an important role by implementing supportive policies, fostering public-private collaboration to develop ICT applications, and by developing and using their own ICT applications.

**Topic Note 10.1: Private-sector Efforts to Integrate Smallholders in Commercial Supply Chains through ICT Applications.** Many companies have taken innovative, instructive steps to include smallholders in supply chains. These efforts are useful to understand because agribusinesses have the motivation, capacity, and resources to create and apply ICTs that help to overcome the problems involved. Private-sector demand for technological solutions appropriate for developing contexts has created a market for ICT applications and spurred innovation in private companies in developing economies, most vividly in India and Kenya.

- EID Parry’s Indiagriline Services Improve Sugarcane Production and Sourcing
- Virtual City’s AgriManagr Builds Better Supply-Chain Links with Farmers

**Topic Note 10.2: Public-sector Efforts to Integrate Smallholders in Commercial Supply Chains through ICT Applications.** The public sector does indeed lead collaborations with other partners, including the private sector, to produce useful applications for a given development context. The public sector can bring together stakeholders that might otherwise be competitors or unable to collaborate effectively. These partnerships require careful structuring, however, and prior agreements regarding revenue sharing and intellectual property rights. Although donor-funded projects present unique challenges to scale and sustainability, they can be overcome.

- ACDI/VOCA’s ICT Solutions Help Private Companies Source from Smallholders in India
- TIPCEE’s ICT Applications Bring Ghanaian Smallholders into Export Supply Chains

**OVERVIEW**

The global food industry has undergone significant structural changes in recent years that have created opportunities for smallholder farmers in developing nations. The inclusion of these smallholders in agribusiness supply chains offers significant opportunities as well as challenges. ICTs can aid smallholders in taking advantage of opportunities and mitigating some of the challenges, as discussed in this module.

**Smallholders in the Global Food Industry: A Complex Relationship**

The global food industry, with over US$ 4 trillion in annual retail sales (Gelhar 2009), comprises agribusinesses of varying sizes. The largest are multinational corporations that operate internationally. In this module, “agribusiness” refers to a wide range of private companies:

- Retailers such as supermarkets or convenience stores (Walmart, Carrefour, ITC Choupal Fresh)
When farmers are insulated by layers of intermediaries, it is difficult to communicate to farmers what items or quality levels the market demands. Reducing the number of intermediaries ("disintermediation") allows companies to reduce, deploy their market power more directly to garner lower prices, and improve quality control.

Direct procurement and improvements in production, transport, and supply-chain technologies make it possible to source competitively from vast numbers of suppliers and increase the relative importance of factor costs such as labor and raw materials. Companies looking to economize move production to places where factor costs are lower, which presents an enormous opportunity for farmers in developing countries (World Economic Forum 2009).

“Commercial supply chain” refers to a supply chain in which a private agribusiness is sourcing agricultural produce from farmers or selling products to farmers in accordance with a profit-seeking business model. “Supply chain” typically refers to the set of buy-sell interactions as goods flow from raw materials through production to the final retailer where consumers can buy them. “Value chain” generally refers to the whole ecosystem of players involved moving from the retailer backward to the producer. These terms are often used interchangeably, and a special distinction is not made in this module. Such chains can be of various types (see figure 10.1).

Although participation in commercial supply chains presents an opportunity for smallholders to attain higher incomes (between 10 and 100 percent; see World Bank 2008:127) and reduce poverty, these outcomes are not certain unless other important factors are addressed. For example, actual income changes depend on the crop, the time needed for farmers to learn to produce the crop more efficiently, and

**FIGURE 10.1:** Examples of Value Chains, Their Participants, and the Value Added Along the Chain

<table>
<thead>
<tr>
<th>Value chain, Ghana</th>
<th>Actor</th>
<th>Value added*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmer - Travelling trader - Wholesaler - Retailer</td>
<td>50% 13% 18%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Value chain, Pakistan</th>
<th>Actor</th>
<th>Value added</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmer - Pre-harvest contractor - Commission agent - Wholesaler - Retailer</td>
<td>92% 11% 16% 31%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Value chain, Ivory Coast</th>
<th>Actor</th>
<th>Value added</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmer - Agent - Trader - Exporter - Processor</td>
<td>9% 15% 60% 24%</td>
<td></td>
</tr>
</tbody>
</table>

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SECTION 3 — ACCESSING MARKETS AND VALUE CHAINS

the quality and other standards required. Changes in income may not be sustainable unless accompanied by improved practices such as postharvest handling or risk management.

Market forces do not in and of themselves guarantee smallholders’ inclusion in modern supply chains. When possible, companies might seek to source from larger producers, who can deliver economies of scale, often are better educated, and typically also have better access to finance. Including smallholders can present significant challenges for both the agribusiness and smallholder, but a strong business case can be made for both sides to work together (table 10.1 summarizes the advantages and challenges).

For agribusiness:

- Smallholders can have distinct competitive advantages in certain situations. Compared to smallholders, large suppliers have greater market reach and multiple options to sell produce, so it can be riskier to source from them. It may also be less risky to source from numerous producers distributed across a wider geographic area, which can reduce systemic vulnerability to floods, droughts, and pests. Uncertainty about prices and quantities is reduced in the short term.
- Smallholders might simply have access to better land or other resources, and they are often more likely to follow the labor-intensive management practices required for higher-quality outputs.
- With smallholders under contract farming, production can adapt more rapidly to market demand.
- Government or donors may offer incentives to include smallholders.

On their side, smallholders can earn higher incomes. Participation also reduces their uncertainty as to who will buy at harvest and how much they will pay. Linking to a modern supply chain might be an important mechanism to address smallholders’ lack of credit, inputs, extension services, and marketing resources (Reardon et al. 2009).

Smallholder inclusion is challenging for agribusiness because interacting with a large group of small suppliers implies high administrative and transaction costs (for example, in controlling quality, maintaining traceability, or ensuring adherence to certification standards). The agribusiness may have to supply physical assets (land, machinery, inputs) and information (on management practices and postharvest practices) for smallholders to produce the quantities and qualities required. Farmers may have to learn how to grow new crops or obtain more costly inputs. Farmers may not honor standing agreements with the agribusiness at harvest, especially if the spot market offers higher prices than the company; the agribusiness may not honor its commitment to purchase from farmers.

In short, a supply-chain relationship between agribusinesses and smallholders is a complicated partnership with difficult requirements on both sides. Procurers need an agreement that will provide them with the right product mix, items that meet safety standards and are traceable, items of the right quality, timely delivery, and a cost-effective arrangement. Farmers require market information, extension services, risk-management capacity, financial services, and supporting physical infrastructure services (such as roads, storage, power, and telecommunications).

**ICTs and Smallholder Inclusion in Commercial Supply Chains**

Modern ICTs and their applications significantly affect smallholders’ inclusion in commercial supply chains. ICT applications (hardware and software), guided by business logic, can foster smallholders’ inclusion by making the following interventions in the supply chain: reducing costs of coordination (collection of production, distribution of inputs, and so
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on); increasing transparency in decision making between partners; reducing transaction costs; disseminating market demand and price information; disseminating weather, pest, and risk-management information; disseminating best practices to meet quality and certification standards; collecting management data from the field; and ensuring traceability.

Such interventions have been driven by the private and public sector. Their slightly different focus and resource base influence the kinds and the sustainability of ICT applications they propound (figure 10.2).

The private sector views its supply-chain relationships as a competitive advantage. The ICT applications it develops to engage with the supply chain and provide information services are typically exclusive to its suppliers. Larger agribusinesses are also likely to have the scale and resources to deploy more expensive, commercially available ICT solutions within their supply chain. These interventions, if supported by a viable business model, are likely to be sustainable, but agribusiness-driven interventions may not necessarily focus on smallholders.

The public sector, donors, and civil society typically see the inclusion of smallholders as a public good. Their intervention in the supply chain is therefore focused on inclusion. The applications they create and develop are less likely to be exclusive. Because they have usually been designed to be specific to particular projects and used only once, public-sector interventions are unlikely to be easily generalizable to other contexts. Sustainability of donor-supported efforts has therefore been more uncertain, though future designs are expected to incorporate learning from previous experiences to enhance sustainability.

ICT for Supply-Chain Management

In conditions of poor information flows supply chains are highly fragmented. Otherwise information technology driven innovations make it easier to acquire, manage, and process information and allow closer integration between adjacent steps in the value chain. There is therefore greater integration of supply chains based on information availability.

Kunaka (2010:24)

Organizations have understood for some time that logistics and supply-chain management (SCM) applications could reduce the transaction costs of procuring from smallholders. Indeed, any sizeable company in the developed world uses SCM systems to handle procurement and other tasks (box 10.1).

BOX 10.1: Functions of Supply-Chain Management Systems

Supply-chain management (SCM) software running on networked computers and handheld devices typically performs some or all of the following functions:

- **Stores information about suppliers.** In the context of sourcing agricultural products from smallholders, this function would allow a food-processing company to know which farmers grow what, as well as other information, such as farmers’ names, locations, previous transactions, and previous performance. Such a database makes it much easier to deal with a large base of smallholders.

- **Enables the company to transmit an order to farmers.** The order would specify what is required, when it will be collected, and how much will be paid for it.

- **Ideally, allows production to be monitored,** making it possible to manage quality and incentivize high-performing suppliers or support poorer performers. The software could provide answers to questions such as which farmers are on schedule, which are behind, and how much product has already been collected from each farmer. If connected to the bank accounts or mobile transaction accounts of the procurer and supplier, such software might also transfer payments when orders are fulfilled.

- **Finally, SCM software might track the transport of goods** from the farm gate to the warehouse or retailer.

Source: Authors.
The lack of context-appropriate software, the prohibitive cost of hardware, and the lack of supporting infrastructure once made it quite difficult to use SCM systems in developing countries. The diffusion of ICT devices (especially mobile phones) and infrastructure has eased these constraints by making it possible to aggregate smallholders virtually. A secondary-source survey of ongoing or recent efforts toward smallholder inclusion using ICTs and their applications suggests that these technologies can solve many supply-chain problems associated with transactions (ordering, invoicing, payment); logistics (collection, storage, transport), quality assurance (safety, traceability); process management (production oversight, input distribution, extension support); and product differentiation (specialization in organic, fair trade, or regional labels) (figure 10.3).

The development of ICT applications for SCM can be driven by a wide variety of agents in the private and public sector, but collaborative partnerships appear to yield more effective applications. For example, agribusiness companies, mobile network operators, third-party service providers, and software firms as well as development institutions and research institutes may participate. It is rare for applications to be developed independently by any one party; collaborative partnerships focused on smallholder inclusion or value-chain competitiveness are much more common.

No single ICT application is ideally suited for all procurement contexts or types of producers and actors along the chain. Organizations vary in size, budget, and operations. Some source perishables; others source staple grains. Supply chains encompass larger and smaller ranges of regions and producers (whose languages and education levels also vary). Not surprisingly, the varying degree of sophistication in ICT applications reflects this diversity. Bigger firms can extend their SCM solutions; other, smaller firms, turn to the off-the-shelf software or applications for mobile phones that are increasingly available; still others rely on spreadsheets. Some applications handle everything from transactions to logistics and quality control. Others focus on a smaller subset of areas. They rely on different combinations of software and hardware, but a combination of mobile phones, PDAs, networked computers, and centralized databases figure prominently in the architecture of most applications. (Module 2 discusses how the accessibility and affordability of ICT devices and infrastructure influence their use.)

Finally, the applications differ in their commercial approach. Some are public goods that do not have a revenue-generating model, while others adopt a one-time turnkey installation fee. Still others take a fee-per-transaction approach, while many follow an embedded service model in which revenues are generated from commercial trading (buying-selling) transactions and a fee for ICT services is not charged to farmers.1

There is a sense that ICT applications can be the glue that holds together complex supply-chain partnerships. The rapid flow of information between buyers and producers that such applications allow minimizes misunderstandings, allows for risk management, provides higher levels of transparency, and ultimately fosters trust.

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1 A discussion about value-chain business models is outside the scope of this module, but readers can turn to World Economic Forum (2009) or Barrett et al. (2010) as a starting point.
A particular area of concern on both sides is the possibility that one side or another will not uphold the preexisting agreement. As mentioned, when prices are high, farmers have an incentive to sell to the spot market (side-sell) instead of to agribusinesses. Similarly when market demand for certain products changes or is lower than expected, procurers have an incentive to buy less than promised or at a lower price (finding produce to be of insufficient quality is a common tactic). Better communication between farmers and procurers, and systems that allow farmers to be paid faster, can reduce such myopic behavior and help relationships endure. If farmers know that side-selling this season will have repercussions in the next because the company keeps electronic records, they might be less likely to engage in this behavior. On the other hand, automated processes in the collection center make it more difficult for buyers to reject products arbitrarily or pay less.

ICTs will not sustain linkages that are fundamentally flawed, however. If the supply chain is not competitive or the business environment or trade laws prove restrictive, software to manage sourcing will not reverse the situation. If market price fluctuations are sufficiently severe, ICT applications may not prevent farmers from side-sell or procurers from reneging.

Finally, the impact of these ICT applications on smallholders’ inclusion in commercial value chains is not yet known. There is a general consensus that participation has a positive effect, but to what extent ICTs enhance or dilute that effect is unknown and requires research. The application of ICTs can be expensive from the perspective of software development or purchase, implementation, training, and so forth. The costs may not be justified in all cases. Better information on potential impact can help to make this determination.

**KEY CHALLENGES AND ENABLERS**

ICTs may create opportunities to incorporate smallholders more effectively into supply chains, but their impact will be limited without the requisite supporting infrastructure, policy, and culture of collaboration. This section describes the challenges and enabling factors associated with using ICT to manage supply chains and integrate smallholders.

Infrastructure is particularly critical for ICTs, which often require reliable electrical power and telecommunications networks. The presence of complementary infrastructure also has much to do with the success of ICT interventions for smallholder inclusion (roads, storage facilities, transportation, and financial infrastructure, among other types).

Commercial value chains prosper in an enabling business environment; policies that support such an environment are indirectly quite important to the effectiveness of ICT applications in supply chains. Policies can also discourage or encourage smallholder inclusion. In India, for example, limits on the size of landholdings make it difficult for agribusinesses to avoid smallholders in favor of larger producers. Until quite recently, policy barriers made it difficult to source directly from farmers at all.

Public-private partnerships have proven critical in developing ICT applications targeted toward smallholder inclusion. Public organizations lack the technical capacity, agribusinesses alone may not have sufficient incentive to reach out to smallholders, and technology companies are reluctant to absorb the risk of producing products unless they are assured of markets. Public institutions can lead such collaborative efforts if they are willing to share rights to outputs of the joint activities.

Public intervention in the private sector’s use of ICTs in supply chains should focus specifically on improvements in the policy environment and the competitiveness of smallholders. An important role of the public sector might be to incentivize smallholder inclusion and provide guidance on technologies that can be used to do so. The public sector might also work to organize farmers into groups and spread financial literacy (ICTs can help here, too; see Module 8).

Finally, the public sector should rigorously evaluate current ICT applications to determine their impact on smallholder inclusion and incomes. Quantitative and qualitative evaluation can include a variety of indicators to document outcomes. Key quantifiable indicators that are relevant to smallholders and can measure impact throughout the chain can include production volumes; product quality; net income; distribution of income among smallholders, within households, and along the supply chain; and the distribution of costs associated with risk mitigation and management.

These indicators can be complemented by additional quantitative measures that assess the overall viability of the supply chain, such as market position and penetration, profitability as compared to similar chains, and trends in volume and prices. Wherever possible, disaggregate data by gender.

Key qualitative or skills-based indicators that have an impact on farmers’ incomes can include key skills related to: (1) the nature and quality of the relationship between farmers and trading intermediaries; (2) improvement in bargaining power; and (3) the governance functions of the chain.
itself. For chains linked to high-value markets, pay additional attention to issues related to product and process upgrading and collective innovation as the chain adapts to increasingly demanding market conditions. While this process does not occur fully at the farmer level, the existence of this skill set is critical for the entire system’s continuing competitiveness. Unlocking innovation and opportunities for smallholders is a critical element of impact, because it leads to benefits that help drive farmers’ incentives for inclusion (K. Kumar, personal communication).

When beginning an intervention, ascertain whether the barriers to smallholder inclusion are best addressed by an ICT application. Care should be taken to ensure the presence of key enablers—special attention is required to include women and other vulnerable groups. It is also important to consider the full cost of ownership beyond any one-time software and hardware fees. Installation charges, maintenance, upgrades, and the cost of training users must also be included.

After diligent consideration, if an ICT application is deemed appropriate, consider existing commercial products before attempting to develop new products. If the development of a new product cannot be avoided, sustainability should be a made a priority, and local partners must be included. A focus on developing standards for ICT applications and systems will allow interoperability between technologies and make it easier to develop new applications when necessary.

Finally, human capacity is critical for the development and uptake of ICTs in supply chains. Farmers or farmer associations may find ICT tools challenging to use (illiteracy, a lack of training, or simply a lack of comfort with modern ICTs are typical barriers). Nor can ICTs be developed or deployed well if a technical talent pool with an entrepreneurial spirit is lacking.

This module continues with two topic notes. Drawing on actual cases (figure 10.4), the notes highlight trends and issues and identify lessons that might prove instructive to others. Topic Note 10.1 focuses on efforts led by the private sector to apply ICTs to the various problems associated with including smallholders in commercial supply chains. Topic Note 10.2 reviews efforts led by the public sector or in collaboration between public and private organizations.

FIGURE 10.4: Cases and Examples Discussed in Topic Notes and Innovative Practice Summaries

<table>
<thead>
<tr>
<th>Supply-chain management</th>
<th>Logistics</th>
<th>Transactions</th>
<th>Market creation</th>
<th>Information provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private &gt;</td>
<td>Suguna Poultry, Godrej Agrovet, OLAM—standard commercial SCM</td>
<td>EJAP Bangladesh—spreadsheets</td>
<td>Virtual City AgriManager—mobile-based application</td>
<td>Muddy Boots, SourceTrade, FarmERP—off-the-shelf SCM specifically for developing contexts</td>
</tr>
<tr>
<td>Public &gt;</td>
<td>ACDI/VocafreshConnect—SCM developed for developing context in India</td>
<td>Mobile Transactions Zambia—mobile-based payments</td>
<td>SAPA Mobile for Agribusiness—mobile-based SCM</td>
<td>TIPCEE—GIS and barcodes for mapping and traceability</td>
</tr>
</tbody>
</table>

Source: Authors.

Payne (2010) provided an immensely helpful starting point for many of the examples and cases in this module.
TRENDS AND ISSUES

Private efforts to use ICTs to include smallholders in supply chains are useful to understand because agribusinesses have the motivation, capacity, and resources to create and apply ICTs that help to overcome the problems involved. Many companies have taken innovative, instructive steps to do so. Private-sector demand for technological solutions appropriate for developing contexts has created a market for ICT applications and spurred innovation in private companies in developing economies, most vividly in India and Kenya.

The specific context is critical in determining if and why any agribusiness will source from smallholders. Private companies often source from smallholders out of competitive necessity, even if doing so can be difficult (Barrett et al. 2010). Quality and certification demands by consumers and export markets also force agribusinesses to assert more control and link backward to the producers in the supply chain. Often there is no choice but to source from numerous smallholders, because they dominate production of certain goods. Corporate social responsibility initiatives may encourage procurement from smallholders; the political context may require it—the ramifications of ignoring smallholders may be significant.

Agribusinesses, especially larger domestic ones and certainly international corporations, already use technology to manage their organizations. When linking backward to smallholders, these companies reflexively turn to technology. It can simply become an exercise in extending their current technologies through the “last mile” to smallholders or deploying more context-appropriate ICTs. Typically, such corporations are more capable than nongovernmental organizations (NGOs) or governments in marshaling the human and financial resources to develop new technologies or extend existing ones. Finally, when these technology needs cannot be met with current systems or commercial software, companies demand solutions that are better suited to the specific context, language, or region, fueling development for innovative new solutions.

At the end of this topic note, two innovative practice summaries illustrate the different ways that the private sector is taking the lead to include smallholders in their supply chains. The first focuses on EID Parry, a company that provides information and technology services directly to farmers in southern India and purchases their produce (sugarcane) at its rural collection centers. The second describes Virtual City, a Kenyan company that produces software to automate and standardize the process of sourcing from a smallholder through rural collection centers such as EID Parry’s in India.

ICT AND SUPPLY-CHAIN MANAGEMENT THROUGH PRIVATE INITIATIVES

As noted, food processors and retailers, especially in India and Latin America, are turning to procurement models that bypass traditional wholesale markets to engage directly with farmers. Through SCM software on networked computers and mobile phones, ICTs facilitate this process in headquarters, field offices, collection centers, farmer cooperative offices, and in the hands of farmers and extension workers. The sophistication and source of the technology, as well as the extent of its reach to smallholders, vary.

Many large organizations simply extend the use of their current ERP software to manage their smallholder suppliers (box 10.2). Such software is used by large organizations to centrally store organizational data and manage data transmission and use between departments within the organization and external partners, such as suppliers. A 2002 report found that typical costs of ownership for an SCM system average about US$ 15 million and can range from US$ 500,000 to US$ 300 million (Sysoptima 2005). These costs represent fees for software, consultants required for installation, and hardware.

For smaller operations, world-class SCM systems may be neither necessary nor cost-effective. These players develop modest systems in-house to manage sourcing challenges. In Bangladesh, EJAB (http://www.ejabgroup.com/) relies on Microsoft Excel and printed forms to track and manage relationships with its potato farmers (USAID 2011).

A market for cheaper ICT solutions has developed owing to the growing trend toward direct sourcing as well as the large number of procurers that cannot afford SCM systems but can no longer get by with simple spreadsheets. The market has especially grown because of the need for applications that
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### BOX 10.2: Companies Use Enterprise Resource Planning Software to Manage Smallholder Suppliers

In India, Suguna Poultry (http://www.sugunapoultry.com/), with annual revenues of US$ 700 million, operates in 11 states. The company sources poultry products from over 10,000 farmers from 270 locations. In 2006, the International Finance Corporation invested US$ 30 million in Suguna to expand production capacity. In the same year, Suguna deployed Oracle’s SCM system across its organization, though it had information systems before implementing Oracle’s product. Agents in field offices interact with the system using computers connected to the Internet to track information and manage the operations of Suguna’s contract farmers.

Suguna is not the only agribusiness in India to move toward world-class SCM software. Godrej Agrovet (http://www.godrej.com/godrej/GodrejAgrovet/index.aspx?id=2), with US$ 300 million in annual revenue from oil palm, animal feed, poultry, and agrochemicals, implemented SAP software in 2010 to manage information and interactions with oil-palm farmers.

These companies follow in the footsteps of their international counterparts. Singapore-based Olam (http://www.olamonline.com/home/home.asp), with revenues of around US$ 8 billion and sourcing operations in over 60 countries, supplies cashews, coffee, and rice. The company uses SAP to manage its interactions with farmers and to support production activities.

Large farmer organizations that source directly from members (some of whom are very small-scale producers) also use ERP software. Module 8 describes the use of ERP software in an Indian dairy cooperative.


ICT applications can improve linkages between procurers and smallholders in indirect ways as well. A phenomenon not limited to India, but highly prevalent there, is agrodealers’ practice of running retail distribution and collection centers in rural areas. These centers (sometimes simple kiosks; see image 10.1) offer ICT-based access to information and extension services to attract farmers to the centers. Farmers are consumers of household items and agricultural inputs sold in these places, but they are also suppliers of agricultural produce. In some instances, farmers have the option of visiting multiple centers nearby, but in other cases, a company that perform specific supply-chain functions that are common for procurers working with smallholders, such as tracking data about producers and their performance over time; communicating orders to farmers; managing production; speeding collection and payment at harvest; and tracing materials along the chain to comply with certification requirements.

Also in demand are applications that can run on mobile phones or other lower-cost ICT devices such as personal digital assistants (PDAs). Supply-chain solutions relying on such devices are better suited for use in developing contexts where computers and Internet connectivity are generally less accessible than mobile phones and wireless service. Several private firms have produced such solutions, and others have been created in joint efforts by private and public organizations (see Topic Note 10.2).

Virtual City (http://www.virtualcity.co.ke/), a ten-year-old company in Kenya, sells pieces of software that address challenges in supply chains. AgriManagr automates the collection of produce from smallholders at rural centers. The system consists of handheld PDAs running the AgriManagr software and smartcards belonging to individual farmers. AgriManagr reduces the time required to collect materials from the farmers and pays them electronically. Information is recorded with fewer errors, and farmers receive a receipt with their previous transactions, which they can use as collateral to borrow. The system strengthens the link between smallholders and procurers by reducing the cost and time associated with the transaction for the latter and by increasing transparency and trust through faster payments for the former.

Collecting information accurately is quite important for firms to manage their operations optimally. Muddy Boots (http://en.muddyboots.com/), a private British software company founded in 1996, has developed a product (called Greenlight) for large aggregators and exporters who are sourcing from many smallholder farmers. This product allows users to track information relevant to standards compliance along the entire value chain. It mostly runs on networked computers, but agents use it on mobile phones at the field level to collect data on production and compliance (Muddy Boots 2007). An American firm SourceTrace (http://www.sourcetrace.com/) offers software with similar features, which has been used in Latin America and India (SourceTrace 2011). Indian software maker Shivarai produces a similar product called FarmERP (http://www.farmerp.com/). Developed in 2003, the product has gone through several iterations and has been available as an Internet-based service since 2007 (FarmERP n.d.).
ICT procures the major crop grown in a place might have the sole collection center in the area.

By offering access to information and other services through their rural centers, companies build farmers’ trust and loyalty. Come harvest time, farmers familiar with the center are likely to sell their produce at the distribution center, which reduces the company’s cost of procuring raw material. In exchange, farmers have access to information that improves the productivity and quality of their crops.

The example cited most often is that of ITC’s e-Choupal service, an extensive network of kiosks—6,500, in 40,000 villages reaching approximately 4 million farmers—where farmers can access an extensive array of information (prices, weather, expert advice) for free. ITC’s revenues come from its commodity transactions and input sales at the kiosks. ITC plans to deepen its relationship with farmers by offering information services via mobile phone (Kumar n.d.).

Many other retailers have followed ITC’s lead. They include Indian Farmer’s Fertilizer Co-Operative Limited (IFFCO) Kisan Sanchar Limited (IKSL), DSCL—Haryali Kisan Bazar (http://www.dscl.com/Business_Agree_HarkisBzr.aspx), Tata Kisan Sanchar (http://www.tatakisanansar.com/), Gojred Adhar, Bharti FieldFresh (http://www.fieldfreshfoods.in/), and Reliance Fresh.

The most hopeful possibility in the near future is the potential for technology development and transfer from major food corporations. Many of these corporations have dedicated corporate social responsibility programs that emphasize smallholder inclusion. A second likelihood is the amalgamation of the mobile-based information services that exist in many countries (one of many examples is Nokia’s Life Tools. Instead of recreating similar services, retailers are likely to simply offer such services to their farmer-suppliers.

LESSONS LEARNED

The private sector can be effective in developing and deploying ICT tools to procure directly from farmers and has demonstrated an interest in doing so. It is less clear whether they are developing tools that will allow them to source from smallholders specifically.

Providing services (information, advice, inputs, finance, and other resources) to farmers can be an effective incentive for them to participate in commercial value chains. Farmers often join value chains to solve market failures in insurance, financial, input, and information markets (Barrett et al. 2010:13). The numerous instances of rural collection centers creating links with farmers by providing access to weather, extension, or other services through Internet-connected computers appear to be effective.

The wide array of private information services available for agribusiness to communicate with or manage their interactions with farmers is still growing. Care must be taken to identify the actual problems that prohibit farmers from participating prior to the implementation of an ICT solution. Knowledgeable experts can provide guidance here.

ICT interventions are not one-time efforts. Technologies and business needs continually change, and the deployment of ICTs must continue to evolve as well.

INNOVATIVE PRACTICE SUMMARY

EID Parry’s Indiag riline Services Improve Sugarcane Production and Sourcing

EID Parry is a large, publicly traded Indian company that sells sugar and fertilizer. It is innovative because it uses
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franchise model to create a network of service and collection kiosks. The kiosks distribute information and other services for smallholders to improve sugarcane production; in turn, they make it easy for farmers to sell their sugarcane to EID Parry. Partnerships play a critical role in the information content provided; the state research and veterinary services are key contributors. While rural distribution centers are not a new concept in India, elsewhere they are less common.

EID Parry depends on smallholders to remain competitive. It sources sugarcane from 80,000–100,000 farmers for nine sugar-processing plants it operates in three states of southern India (M.C. Gopinathan, personal communication) and earned over US$ 280 million in revenue in 2010 (EID Parry 2010). When India began to remove import restrictions in response to pressure from the World Trade Organization in 1997, agribusinesses like EID Parry had to optimize their production to reduce costs and stay competitive. EID Parry was already cost efficient in production, but there was scope to reduce the cost of sourcing sugar. The company had a clear incentive to work with its large farmer base to increase productivity and improve quality.

The Rural Kiosk Network and Indiagriline
In response to the need for larger quantities and higher quality, the company developed Indiagriline (http://www.indiagriline.com/) in their Research and Development Department. Indiagriline is a web-based portal that provides farmers with information to improve productivity and quality, such as market prices, weather alerts, and advisory and extension assistance as well as supply-chain information (image 10.2).

Supply-chain information comes to farmers through EID Parry’s Cane Management Software, which enables farmers to forecast demand, access records of their previous transactions with the company, register their sugarcane area, submit payment information, and monitor demand, among other services. Most of the content consists of the extension information provided by state universities or independent foundations in partnership with the company.

In the pilot launched in 2001, 16 kiosks, called “Parry’s Corners,” were deployed with the Indiagriline system in 16 villages near the largest sugar factories. These kiosks were connected to a main Internet server in the factory by a cheap, easy-to-maintain wireless access technology called “corDECT” (FAO 2005).

Franchise Business Model
Instead of paying for and operating the kiosks, the company opted for a franchise model. Independent local entrepreneurs became franchisees by investing US$ 1,000 for space, computers, and standard equipment such as a printer, power backup, telephone, and furniture. They also pay for operational costs such as Internet and power. The company offers financing through local banks if necessary.

In exchange for the franchise arrangement, EID Parry provided training and assistance to the franchisees and the right to use the brand, sell products, and source sugar on behalf of the company. Over the first years of project, EID Parry spent US$ 500,000.

Operators can expect to earn US$ 16–40 per month. The franchisees earn their revenue from additional services offered at the kiosks along with Indiagriline. The information service acts to attract customers and create effective demand for the other services. The most important of these is the procurement of sugarcane from farmers. Incentivized by prompt payment and fair weighing, sorting, and transaction records, farmers sell to EID Parry instead of the local market. The kiosk also acts as a rural retail outlet, selling agricultural products such as fertilizer and seed alongside household items such as oil or processed sugar. Finally, the kiosks also allow farmers to access educational programs, farm extension services, banking and insurance services, and communications over phone and Internet.

Besides Indiagriline, some of these other services also rely on ICTs, especially remote agricultural extension. Farmers use email and digital cameras to reach agricultural experts remotely for crop diagnostics.
Impact, Scalability, and Sustainability

As FAO (2005) notes, the information system obviously removes critical barriers that have kept farmers from participating in the commercial sugar supply chain. Farmers receive relevant and timely information regarding sugarcane production, the company effectively communicates demand and quality requirements, and farmers can demand a fair price and be assured of a market. Further, agricultural yields, access to finance, agricultural extension services, and time required to transact with EID Parry all have reportedly improved.

These improvements have not been quantified, however (FAO 2005). The Indiagriline project was started in 2001 with a stated goal of “increasing farmers’ incomes three times in five years,” but no systematic evaluation has determined the precise impact on sugarcane farmers’ incomes. It is also not clear whether more farmers are participating in the supply chain because of Indiagriline.

Eventually the ubiquity of cheap mobile phones (even among smallholders) and reliable Internet connections did away with the need for farmers to come to a kiosk for information. Urbanization fed a critical labor shortage for production operations and harvest. The company realized that labor shortages made the mechanization of production and harvesting operations essential.

The Parry’s Corner kiosks have been transformed and renamed Parry Mayams, and 82 of these rural centers cover all of the areas that EID Parry sources from, acting as rural retail outlets to sell inputs, equipment, and other services. The centers, like the kiosks that preceded them, continue to run on the entrepreneurial model that supported the kiosks. They also provide complete farm management services to landowners who no longer wish to manage their land themselves—the company calls this “business process outsourcing for farmers.”

ICTs in various forms are integral to delivering these services. Mobile phones and SMS deliver weather, price, market demand, and operational information to farmers from a centralized IT operation of EID Parry. Much of this information was previously provided through Indiagriline, but farmers no longer need to come to the kiosk and log on to the system. Currently, 60 percent of EID Parry’s farmers receive mobile phone messages, and the company is planning to include all farmers. Extension workers have access to Internet-connected netbooks to provide better information to farmers for optimal cane growth.

As of April 2011, the company was also piloting a call center at one factory to field farmers’ questions. After a few months, the center was receiving 80–90 calls per day. If the pilot proves successful, the service will be extended to the other factories.

EID Parry considered partnering with commercial information service providers instead of creating their own capacity, but they concluded that existing services restricted their farmers’ choices. For instance, Nokia Life Tools requires the use of Nokia phones. Netbooks were chosen over handheld Palm devices to access the Internet and move data through wireless mobile networks.

INNOVATIVE PRACTICE SUMMARY
Virtual City’s AgriManagr Builds Better Supply-Chain Links with Farmers

Virtual City is a private Kenyan technology startup founded by entrepreneur John Waibochi in 2000. The company had its beginnings in e-commerce but shifted its focus to developing software applications that manage supply chains, knowledge, and customer relationships. In response to a perceived market opportunity, Virtual City developed its AgriManagr software.

AgriManagr Builds Trust Among Supply-Chain Partners

The AgriManagr software is used by collection centers to manage the process of buying agricultural produce from farmers (figure 10.5). The application runs on mobile phones or PDAs.

When a farmer brings his or her produce to the collection center, it is weighed using an electronic scale that sends data via Bluetooth wireless technology to a handheld device. The data are appended to the farmer’s transaction record. The farmer (who is uniquely identified through information on his or her smartcard) is paid without cash through a mobile payment system and given a printed receipt (the scale is wirelessly connected to a printer) noting the current transaction.

The receipt also contains a record of the farmer’s previous transactions at the collection center. It serves as a proxy for the farmer’s creditworthiness, just as a credit history does in

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5 The section draws on information from an interview from an EID Parry executive (Gopinathan 2011).

6 This and the next section draw on information from Virtual City (2009).
developed nations. The farmer can use a record of consistent earnings at harvest as collateral for credit.

Data from the collection center are held in the PDA until they can be uploaded or wirelessly transmitted to a main server in the field office, where all the data from various collection centers are gathered and consolidated. Data from various field offices are sent over the Internet to headquarters, where they are consolidated. In this way, field offices and the headquarters are immediately aware of how much of what has been collected, from where, and when.

In the meantime, the collected products are sent to warehouses where entire truck payloads can be weighed. The weight is recorded and sent to headquarters, where it can be cross-referenced with the data from collection centers and field offices to ensure no product was lost on the way to the warehouse.

**Impact, Scalability, and Sustainability**

AgriManagr has been deployed by at least a handful of customers across several sectors, all in Kenya (M. Kagochi, personal communication). They include the Kenya Tea Development Authority, which controls about 60 tea factories, and Brookside, Kenya’s leading milk processor. Technoserve reportedly uses the product for coffee-sector interventions, and a Virtual City executive also noted use in the cotton sector. The company won a grant of US$ 750,000 from the Africa Enterprise Challenge Fund to automate the dairy supply chain using AgriManagr (AECF 2009).

AgriManagr has several benefits for both the procurer and the farmer. It eliminates the manual transcription that inevitably results in record-keeping errors or fraud. It speeds procurement and sharpens management’s view of the process, thus increasing its ability to respond rapidly to bottlenecks or opportunities. Farmers, the company claims, receive an average weight that is 9 percent higher than weights recorded using manual scales. Farmer presumably benefit from rapid cashless payment and from being able to use their transaction records to obtain credit.

Evaluations that could answer two fundamental questions are still lacking, however. Are farmers in the value chain earning more owing to the implementation of this technology? Can more farmers participate in the value chain than previously? Both questions need formal consideration.
Topic Note 10.2: PUBLIC-SECTOR EFFORTS TO INTEGRATE SMALLHOLDERS IN COMMERCIAL SUPPLY CHAINS THROUGH ICT APPLICATIONS

TRENDS AND ISSUES
The public sector can help smallholders participate in commercial supply chains by helping them to develop relationships with agribusinesses and to grow products that the market demands. Public organizations have facilitated the creation and deployment of various ICT applications to reduce transaction costs associated with the interaction between producers and procurers, better monitor the production process, and improve traceability. As these technologies and their applications become more appropriate to local contexts and needs over time, they are likely to become indispensable for smallholder inclusion.

A special focus on efforts led by the public sector is warranted for a number of reasons. First, public organizations have a unique role to play in enhancing competition, facilitating smallholders’ participation in commercial supply chains, and ensuring higher earnings for those that do participate. The growing processed-foods market and urban consumers’ preference for supermarkets do not necessarily translate to higher competition among procurers or automatically imply the inclusion of smallholders (World Bank 2008).

Second, public organizations can push for policy changes and make systematic interventions. They can coordinate partnerships between parties in the supply chain that create value but would be difficult for any single player to facilitate. For example, they can invest in both ICT and non-ICT infrastructure.

Third, public organizations can deploy technology and other resources to support and maintain such partnerships and help farmers become more productive, produce the right mix and quality demanded by the market, and meet the certification requirements for participating in high-value supply chains. To source from smallholders, at times it may be beneficial for a private organization to invest in public goods such as roads, extension services, access to finance, and market information, but often this is not the case. The public sector generally provides such public goods.

Two innovative practice summaries follow this topic note. In India, Agricultural Cooperative Development International/Volunteers in Overseas Cooperative Assistance (ACDI/VOCA) is an excellent example of how a public organization can coordinate other supply-chain players, both private and public, to include smallholders. In Ghana, USAID’s TIPCEE project aims to link fruit and vegetable exporters to the international agriculture and trade value chain. An interesting feature is the use of barcodes and GIS to trace exports back to their place of origin.

PUBLICLY SUPPORTED ICT FOR SUPPLY-CHAIN MANAGEMENT
The unique role of public organizations is reflected in the way they use ICTs and ICT applications to foster smallholder participation. Public efforts have focused on creating nonproprietary software and platforms that can be used by multiple procurers and suppliers within supply chains or that can be applied to supply chains for different products altogether.

The spread of telecommunications infrastructure and devices such as mobile phones, PDAs, radio-frequency identification (RFID), and global positioning system (GPS) have made it possible, cost-effective, and useful for public agencies to work with private partners to develop context-specific software for SCM. Many of these applications seek to enhance the competitiveness of entire agricultural supply chains and foster the inclusion of smallholders.

Aside from the examples detailed in the innovative practice summaries, in Indonesia, the Institut Teknologi Bandung incubated the development of SCM software in partnership with Nokia, the Korean International Cooperation Agency, various Indonesian government ministries, and local corporations. Like many similar applications, SAPA Mobile for Agribusiness (http://akucintaindonesia.com/), runs on mobile phones and networked computers. Now a private venture, SAPA links over 5,000 small-scale organic rice producers into commercial export supply chains. Smallholders in Sukabumi, West Java, Serdang Bedagai, and North Sumatera regions participate; further expansion is planned (Kumar n.d.:35–36).

While not all efforts are so comprehensive, some have unique features, such as the incorporation of mobile payments, which nevertheless serve to establish links between farmers and agribusiness. In Zambia, the USAID-funded PROFIT (Profit, Finance, and Improved Technologies) project helped establish a partnership between the cotton-producing company Dunavant Zambia Ltd. and Mobile Transactions, a mobile payment provider (Chemonics 2010).
Dunavant (http://www.dunavant.com/) found it difficult to pay its contract farmers on time. The prospect of slow payment from Dunavant caused cash-strapped farmers to sell to local dealers, even though farmers could earn more from selling to the company (Zachary 2007). By partnering with Mobile Transactions, Dunavant can pay farmers instantly using mobile phones and Mobile Transactions’ network of agents (figure 10.6). Facilitating payments as well as access to finance is a powerful mechanism to link farmers to supply chains (see IPS “Kenya’s DrumNet Links Farmers, Markets, and Financial Service Providers” in Module 7).

Some public efforts have used ICTs to include farmers in commercial supply chains by improving the traceability of produce. For example, Fruitéra (a Malian fruit and vegetable exporter) assisted mango small-scale producers to comply with GlobalG.A.P. standards, helping them reach high-value export markets (see Module 12 for details). Another example, TIPCEE, is discussed later in this module.

LESSONS LEARNED

The public sector does indeed lead collaborations with other partners, including the private sector, to produce useful applications for a given development context. The public sector can bring together stakeholders that might otherwise be competitors or unable to collaborate effectively. These partnerships require careful structuring, however, and prior agreements regarding revenue sharing and intellectual property rights. ICTs developed by the public sector provide the visibility, communication, and speedy transactions that keep partners together for mutual benefit.

Not surprisingly, the public sector focuses more on smallholder inclusion than the private sector does, so it tends to develop ICT solutions focused on this objective. The resulting products differ from those developed by the private sector, especially with regard to exclusivity. SCM solutions from the public sector are usually not for the exclusive use of one buyer. They are generally platforms that multiple buyers, public or private, can plug into.

A general drawback of buyer-driven models for producers is the frequent demand for exclusivity. From a processor’s or retailer’s perspective, a supply chain is a source of competitive advantage, and these actors will seek to exclude competitors and prevent suppliers from side-selling. Because a buyer has invested in the supply network, and because the buyer needs to able to fulfill contractual obligations for specific volumes to its customers, the buyer will demand exclusivity from its smallholder suppliers (K. Kumar, personal communication).

Donor-funded projects present unique challenges to scale and sustainability. Low-cost, context-specific software, for example, can have difficulties supporting higher volumes, and in such cases success can lead to collapse. In other cases, the products are too specialized and cannot be applied to other projects. ICT applications are not one-time interventions. Hardware and software must be maintained.

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and upgraded. The funds and human capacity to do so might be in short supply after a project is completed, unless special care is taken to ensure sustainability.

Strong local partners who can support a product are critical, but products and services should ideally be designed to become commercially viable and self-sustaining. The substantial learning from deploying ICTs provides good reason to think that future donor-funded projects might overcome many of these challenges to scalability and sustainability (see, for example, Ducker and Payne 2010).

INNOVATIVE PRACTICE SUMMARY
ACDI/VOCA’s ICT Solutions Help Private Companies Source from Smallholders in India

ACDI/VOCA innovated by working with Infosys to develop SCM software that reduces the barriers private organizations face in sourcing from India’s smallholders. Beyond developing the software, ACDI/VOCA developed the business case for its use by several large food logistics firms. The case demonstrates significant and successful collaboration but also shows the challenges for ICT applications to become sustainable and achieve scale.

ACDI/VOCA is an American nonprofit with annual revenue of US$ 124 million. It was founded in 1963 and has conducted economic development projects in more than 145 countries. Success with a project to integrate small-scale Indian producers of fresh fruits and vegetables into commercial supply chains (the India Growth-Oriented Microenterprise Development Program, GMED) (ACDI/VOCA 2011) led to a grant from USAID in 2006 to develop “ICT-enabled applications to improve the efficiency of private sector extension services and fresh produce supply-chain management in India” (McCarthy, Kumar, and Pavlovic 2009).

Based on the GMED experience, ACDI/VOCA had learned several lessons about the difficulty of sourcing fruits and vegetables directly from smallholders. They quickly realized that the “only means of guaranteeing a reliable supply and remaining competitive is to establish ongoing, mutually beneficial partnerships with organized groups of farmers.” (ACDI/VOCA 2011)

Such partnerships would have to overcome several problems. Farmers lacked access to production and postharvest skills and the knowledge and technology to produce the right mix, quality, and quantity of produce. Farmers also needed market information systems to learn about prices and demand trends. Monitoring and traceability were increasingly required to sell to domestic and export markets, and interactions between a large base of farmers and the procurer needed to be coordinated and managed effectively and efficiently.

Collaborative Development Process
In response to these needs, which ACDI/VOCA realized could be addressed at least partially through the use of ICT, the organization set about developing an appropriate application. They decided it would be based on wireless mobile networks to leverage India’s high-growth telecommunications market, low wireless service rates, and the need for real-time information in managing a supply chain for perishable fruits and vegetables.

To augment their own learning, ACDI/VOCA hired Accenture Development Partnerships to analyze the need for an ICT solution and determine which capabilities would add the most value. In a competitive bidding process, they selected Indian software giant Infosys to develop a product that would be commercially viable and obviate the need for donors to support future development and maintenance. A critical piece of the agreement was ACDI/VOCA’s willingness to allow Infosys intellectual property rights over the software (McCarthy, Kumar, and Pavlovic 2009).

ICT Application
By 2008, this extensive collaboration had resulted in freshConnect, a software application that could be accessed by networked computers, mobile phones, and PDAs using wireless technologies. Figure 10.7 depicts the partners’ contributions.

FIGURE 10.7: Partnerships Involved in Developing freshConnect

Source: Authors, based on ACDI/VOCA 2011.
The software has three main modules. The first module (Order Placement) allows procurers to place an order, which field agents then divide among suppliers. The application continuously monitors prices at wholesale markets to determine minimum and maximum prices that the procurer will pay when placing an order. The quality required can also be specified when the order is placed. The second module (Order Fulfillment) allows field agents to collect information on the quality and quantity produced at harvest. The third module (Order Shipment) allows field agents, farmers, and procurers to track the produce and trucks in transport.

**Business Model**

After a pilot phase, the software became commercially available through Infosys, which charges a setup cost and a transaction cost based on the volume of produce supplied. Two major Indian food retailers, HyperCity (http://www.hypercityindia.com/index.asp) and Radhakrisna Foodland (RF) (http://www.rkfoodland.com/), became the first agribusinesses to use the software commercially to source directly from a cooperative of more than 300 farmers.

**Impact, Scalability, and Sustainability**

Farmers and procurers have benefited from the use of freshConnect. Farmers have unfiltered access to market demands and can plan their production knowing that their product will be bought. They know the price they will receive as well as the technical information to produce it at the required quality. Procurers are able to specify quantity, quality, timing, and price information in placing an order, which reduces uncertainty and wastage.

Farmers report earning 15–20 percent more through freshConnect. HyperCity and RF report a 10–15 percent reduction in postharvest wastage. An independent evaluation has yet to be conducted to verify these claims.

An additional 200 farmers had joined the chain to supply HyperCity and RF by 2009, and the freshConnect software has the capacity to scale with additional hardware. The pilot ran into a number of problems that have inhibited wider application, however.

The financial crisis of 2008 ultimately caused RF to go out of business. At the same time, other commercially developed information services such as RML entered the space. Additional customers have not signed on to use freshConnect because the product is more expensive compared to those of new market entrants. Finally, Infosys has not succeeded in tailoring the licensing terms and marketing efforts to retail grocery chains (Pavlovich and Cech, personal communication).

Nonetheless, freshConnect remains under the ownership of Infosys, where it continues to be developed and marketed. Several lessons with regard to sustainability were offered by the project manager from ACDI/VOCA:

- **Information services alone will not lead to smallholder inclusion.** Additional services, especially extension, are required, but delivering extension services only by phone is quite challenging. Farmers often prefer face-to-face interaction with extension agents.

- **Understanding farmers’ requirements and willingness to pay for a product is critical for sustainability.** This understanding is difficult for software developers or project designers to attain if they are not intimately familiar with farmers’ environment. For instance, various mobile information services provide price information. These services typically update prices daily when, in fact, intraday price fluctuations can be significant for farmers.

- **ICTs should be localized.** “Localized” does not just mean that an ICT application is available in the local language. Instead of displacing existing relationships and processes at the local level, ICTs should fit into existing relationships to augment their capacity.

**INNOVATIVE PRACTICE SUMMARY**

**TIPCEE’s ICT Applications Bring Ghanaian Smallholders into Export Supply Chains**

USAID’s Trade and Investment Program for Competitive Export Economy (TIPCEE) in Ghana was innovative in its use of ICTs to enable fruit and vegetable exporters to become sufficiently competitive to link with international value chains. The project used barcodes, GPS, and geographical information system (GIS) to ensure that produce could be traced to the smallholders who grew it—a major requirement to participate in the target export markets.

A five-year (2005–09), US$ 30 million project, TIPCEE focused on the maize, pineapple, tomato, citrus, and onion supply chains. Its goal was to increase export sales to European and United States markets by US$ 75 million over the life of the project and to affect the lives of at least 15,000 farming households (this number was revised to 100,000 after a successful first year). This large project covered 58 percent of Ghana’s districts (CARE 2008).

The project’s two main initiatives were to: (1) include smallholders in supply chains by systematically improving product
quality and reducing costs and bottlenecks in each supply chain and (2) implement broad policy reforms to improve the enabling environment around the supply chains and make them more competitive (Chemonics International 2006).

As discussed, produce exported to international markets must typically meet stringent certification standards, which often require traceability. The consumer needs to know the origin of each individual product in a supermarket.

**ICT Application**

The TIPCEE project used GIS and barcode applications with GPS readers, barcode scanners, a wireless mobile network, and networked computers to address the traceability problem. GPS readers communicate with global positioning satellites to indicate the exact location of a place on the earth’s surface through latitude and longitude coordinates. These coordinates can be collected from the boundaries of a particular farm and fed into a GIS application on a computer, which can map the location of the farm, often with great precision.

Once a farm is mapped electronically, a product from that farm can be traced back easily to the source if the product is marked with the coordinate information, which can be done with barcodes but is typically done by physically marking the items. The advantage of barcodes is that, once assigned, they can be scanned at points along the supply chain to track not only the origin but the path of goods from the farm to the end consumer. In this way, GIS maps can, in conjunction with barcodes, ensure traceability.

**Business Model**

There is no business model in this particular case because TIPCEE as well as the GIS component is supported by the donor. A business case for such an investment is not difficult to make, however. For example, if traceability allows products to enter a high-value international market, the gain in revenue should easily pay for the equipment and labor required to maintain a GIS.

**Impact, Scalability, and Sustainability**

The use of precise electronic maps can lead to superior production planning (actual area is often below declared area; see figure 10.8) and yield forecasting. Knowing the location and size of farms makes it easier for procurers to monitor production and improve the targeting of assistance and inputs. Ideally, traceability makes smallholders more attractive.

![Figure 10.8: Declared and Actual Area Can Differ Significantly (Citrus farms)](source: Adapted from USAID 2009.)
suppliers to exporters. It is unclear whether GIS mapping affected TIPCEE farmers’ incomes or inclusion in a particular supply chain, however. What is known is that by 2009, 12,000 farms on more than 20,000 acres had been mapped for all types of crops (USAID 2009). The use of GIS mapping is replicable elsewhere if funding and training are available.

The initial mapping was a result of the project, which is now completed. To increase the likelihood of sustainability, TIPCEE implementers trained the staff of three firms specializing in horticultural exports, two NGOs, and over 250 farmers, staff members of private firms, and agents of the Ministry of Food and Agriculture to use GPS devices and GIS software. The training covered creating, maintaining, and updating electronic maps. TIPCEE also facilitated discussions with international research institutes (such as IFPRI) and the University of Ghana to create standard practices and formats for platforms and data storage so that current maps will remain compatible with future maps.

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