INFORMATION AND COMMUNICATION TECHNOLOGIES

Farmers, Markets, and the Power of Connectivity

Maximo Torero

SUMMARY Roughly three-fourths of the world's poor live in rural areas. What role can information and communication technologies play in empowering them? This chapter explores the potential for these technologies, especially mobile phones, to stimulate agricultural and rural development through the provision of information and capacity-building opportunities.

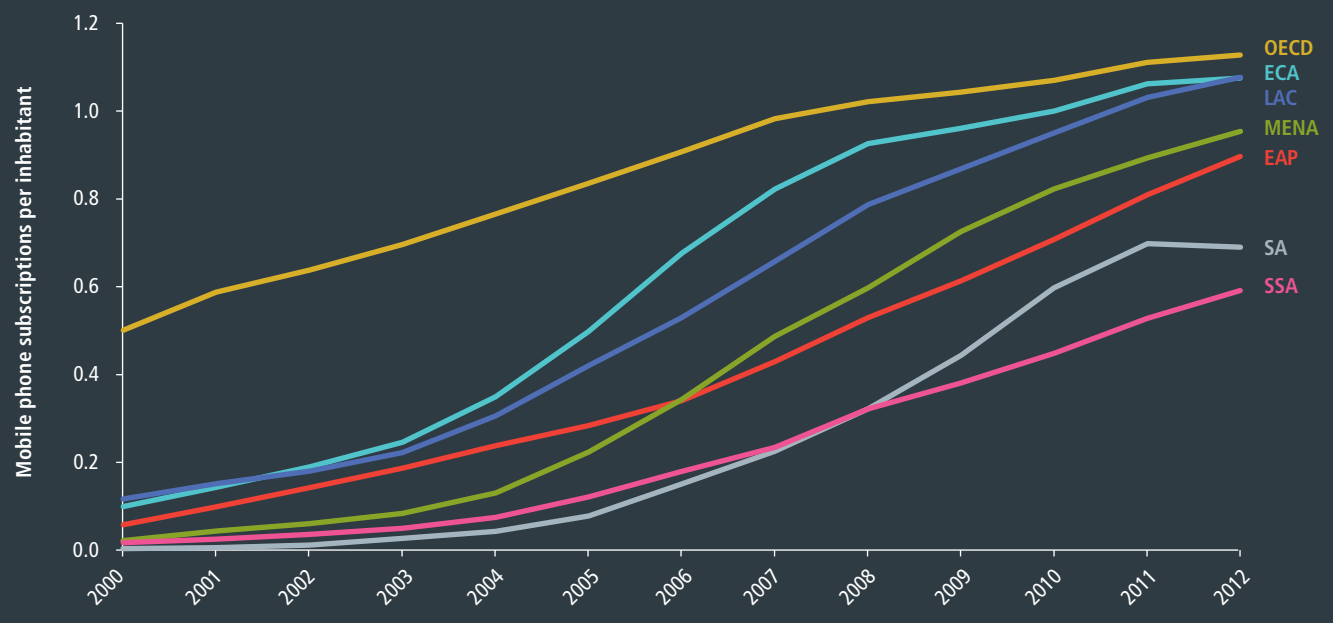
Addressing global poverty is not possible without considering rural populations in developing countries, especially smallholders. Roughly three-fourths of the world's poor live in rural areas.[1] In South Asia, Africa south of the Sahara, and East Asia and the Pacific, the rural population represents more than half of the total population of each region. These three heavily rural regions are home to about 1.1 billion poor people who live on less than US$1.25 a day—the international poverty line—and who account for roughly 90 percent of the world's poor.[2]

What major challenges do rural populations face? High on the list is lack of access to physical products as well as to new technologies and ideas. This lack of access may limit agricultural output and impede improvements to health and education outcomes. In addition, by leading to unsustainable agricultural practices and resource use, it could arguably be related to environmental degradation.

A growing body of evidence suggests that in many circumstances, information and communication technologies (ICTs), specifically mobile phones, can help address these problems. Such technologies are thought to increase access to both information and capacity-building opportunities for rural populations in developing countries. Policymakers, in turn, can also benefit from increased information sharing, which allows them to gather a more complete overview of the situation on the ground in their country. These technologies may play a key role in improving many sectors—from agriculture and food security to health care, education, and financial institutions.

Maximo Torero is director, Markets, Trade and Institutions Division, International Food Policy Research Institute, Washington, DC.

FIGURE 1 MOBILE PHONE SUBSCRIPTIONS PER INHABITANT, BY REGION, 2000–2012



Source: Adapted from Figure 1 of E. Nakasone, M. Torero, and B. Minten, "The Power of Information: The ICT Revolution in Agricultural Development," *Annual Review of Resource Economics* 6 (forthcoming 2014). Mobile phone subscriptions are from the International Telecommunication Union, and country categories are from the World Bank.

Notes: EAP = East Asia and Pacific; ECA = Europe and Central Asia; LAC = Latin America and the Caribbean; MENA= Middle East and North Africa; SA = South Asia; SSA = Africa south of the Sahara; and OECD = high-income countries only. Developing world = ECA, LAC, MENA, SA, and SSA.

This chapter assesses the potential of such technologies, including mobile phones, to help break the poverty trap faced by smallholders in developing countries.

THE SPREAD OF INFORMATION AND COMMUNICATION TECHNOLOGIES

The exponential increase in access to mobile phones in the past decade has clearly reduced the digital divide between developed and developing countries (Figure 1). In fact, several developing countries currently have higher rates of penetration per inhabitant than developed countries. In 2012, Europe, Central Asia, and Latin America and the Caribbean were home to more mobile phone connections than people. By 2013, the number of mobile phone subscriptions worldwide had approached the global population (Figure 2). Phone subscriptions have also increased dramatically in Africa south of the Sahara. This huge jump in accessibility, if combined with a supply of high-quality information, could open a significant window for the use of these technologies in development. In particular, information and communication technologies could help lift smallholders out of poverty by giving them a better understanding of lucrative markets, leading them to enter these markets, and allowing them to realize increased gains from trade.

Although many information and communication technologies undoubtedly have potential to enhance rural livelihoods, most are not as widespread as mobile phones. For example, as of 2012, there were only 0.11 landlines per inhabitant in developing countries (Figure 3).[3] Although increasing, access to the Internet is still far from extensive: only 27 percent of the population in developing countries uses the Internet, and there are only 0.05 broadband subscriptions per inhabitant. In contrast, by 2012, there were 0.82 mobile phone subscriptions per capita in the same group of

countries, many of which have more subscriptions than people.

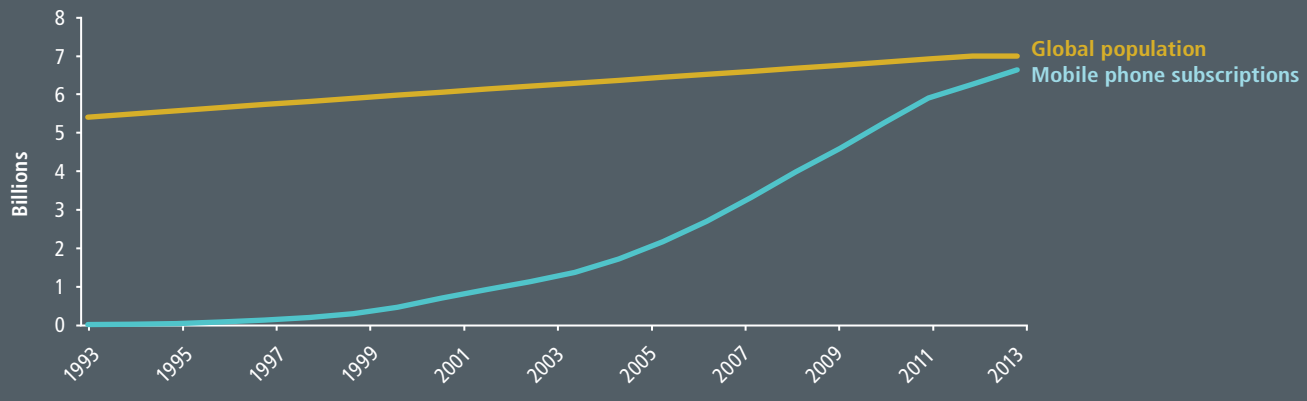
HOW INFORMATION AND COMMUNICATION TECHNOLOGIES MIGHT HELP SMALLHOLDERS AND IMPROVE FOOD SECURITY

An increasing body of evidence highlights the potential for information and communication technologies to improve the lives of the poor. Increased access to and adoption of new technologies can address the challenges of food insecurity on multiple fronts, including increasing households' access to nonfarm income and enabling households to better gauge the safety, quality, and nutritional value of their food.

Information and communication technologies can make poor populations more resilient in several ways. First, access to technology can increase the amount, timeliness, and quality of information available to the poor. Preliminary research suggests that this in turn can translate into better job opportunities (as the poor establish better contacts) and higher crop yields (as they get access to timelier and better-quality information on products and inputs as well as environmental and market conditions).[4] Second, these technologies may promote learning, which itself can enhance technology adoption among farmers.[5] Lastly, though no evidence is available, it is conceivable that improved access to health and nutritional information through these technologies could help reduce the prevalence of hunger among the poor.

There are many reasons to believe that these technologies may have a large impact on agricultural markets. For example, they can allow different market agents to communicate more efficiently, thus enhancing information flows. This impact can be critically important for rural areas in developing countries, where inadequate infrastructure tends to make markets less integrated. Mobile phones are particularly good at spreading information (Figure 4). As of October 2013, 98 mobile phone projects were being implemented in the agricultural sector of developing countries.[6] Arguably because of their wide availability, mobile phones are used in most of these projects. Delivery of information is mainly through short message service (SMS), although voice messages, interactive voice response systems, or mobile applications are also used. Most projects deliver information regarding market prices (48 percent) and agricultural extension (39 percent), combined with weather advisory information in a number of important cases.

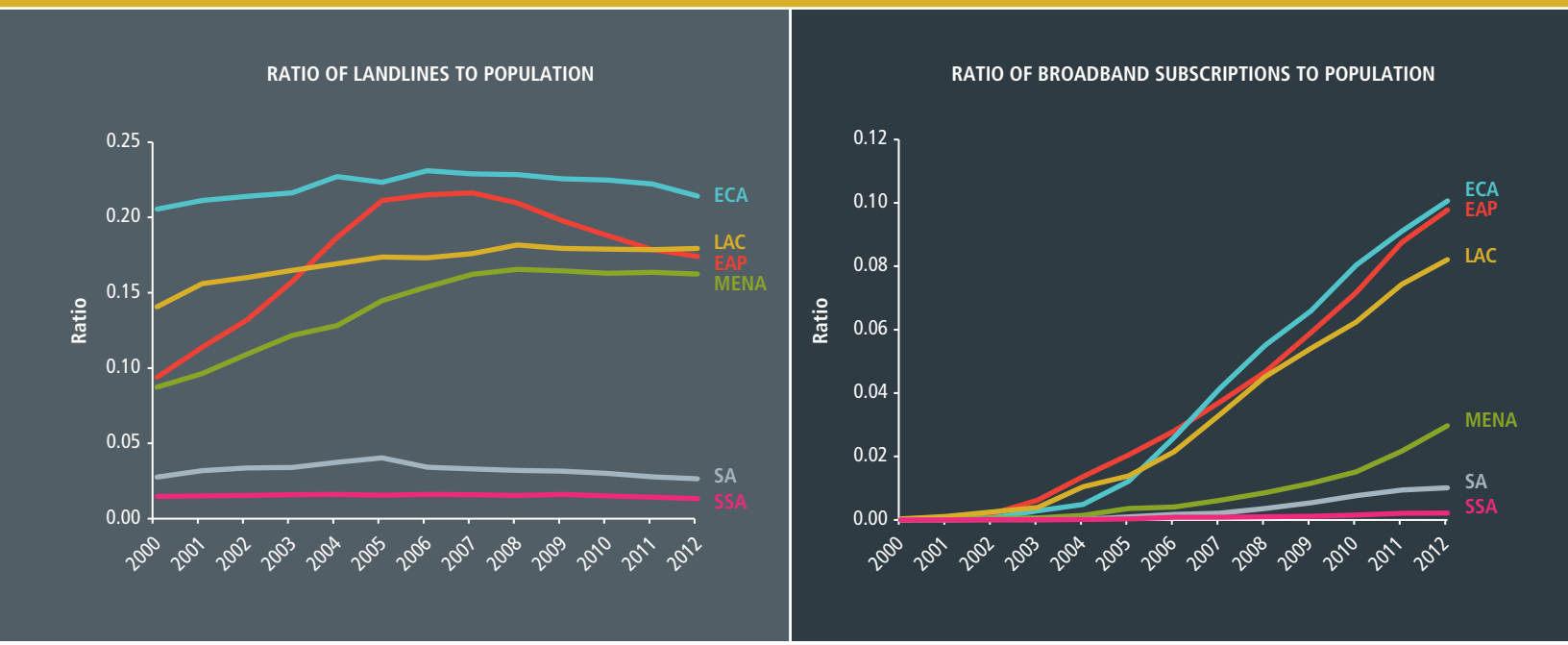
FIGURE 2 MOBILE PHONE SUBSCRIPTIONS AND GLOBAL POPULATION, 1993–2013



Source: Mobile phone subscriptions are from the International Telecommunication Union, and population figures are from the World Bank.

Note: Data for 2013 are incomplete.

FIGURE 3 LANDLINES AND BROADBAND PENETRATION FOR SELECTED REGIONS, 2000–2012



Source: Adapted from Figure 1 of E. Nakasone, M. Torero, and B. Minten, "The Power of Information: The ICT Revolution in Agricultural Development," *Annual Review of Resource Economics* 6 (forthcoming 2014). Data on landlines and broadband subscriptions are from International Telecommunication Union (mobile phone subscriptions) and the World Bank (country categories).

Notes: EAP = East Asia and Pacific; ECA = Europe and Central Asia; LAC = Latin America and the Caribbean; MENA= Middle East and North Africa; SA = South Asia; and SSA = Africa south of the Sahara. High-income (OECD and non-OECD) countries are excluded from the sample.

Of the main potential gains from information use in agricultural markets, the most important is market efficiency.[7] Prices, in essence, can signal opportunities to producers, consumers, and traders—such as when excess demand is creating more profitable opportunities to sell or when excess supply leads to cheaper deals. For example, through increased access to mobile phones, farmers can better plan how much to plant each season and how much and what type of investments could be profitable based on supply-and-demand fundamentals.[8] They can also gather information from extended networks and cooperatives regarding market conditions and quality standards in higher-end markets. Better information through the use of these new technologies can generate a more efficient allocation of products, thereby creating higher overall gains for all market participants and allowing farmers either to find markets offering higher prices or to better negotiate with traders.

Anecdotal evidence suggests that these technologies might also affect transportation costs for both inputs and crops. A farmer in India related his experience this way: "I was in process to transport my produce of [approximately 1,000 boxes in two trucks] to Delhi when I got an SMS through RML [Reuters Market Light, a mobile phone–based information service] that the freight rate from Kotgarh to Delhi is Rs [rupees] 41.07 per box. I showed this message to the truck operator, who till then was citing a rate of Rs 44 per box. Following this I was able to settle the transporting deal at Rs 41.07, finally saving around Rs 3,000."[9]

Information and communication technologies can also be used to reduce price variability. In a context of limited information—and thus limited arbitrage—prices tend to vary based on the current local supply. As information flows improve, however, more opportunities for arbitrage emerge, effectively limiting the influence of local fluctuations and more closely relating market prices to less volatile aggregate supply. For example, farmers in areas with surplus harvests can sell their products to areas facing shortages. Finally, improved information can teach households about more profitable crops or previously unknown agricultural

techniques, thus potentially influencing production patterns in the long term.

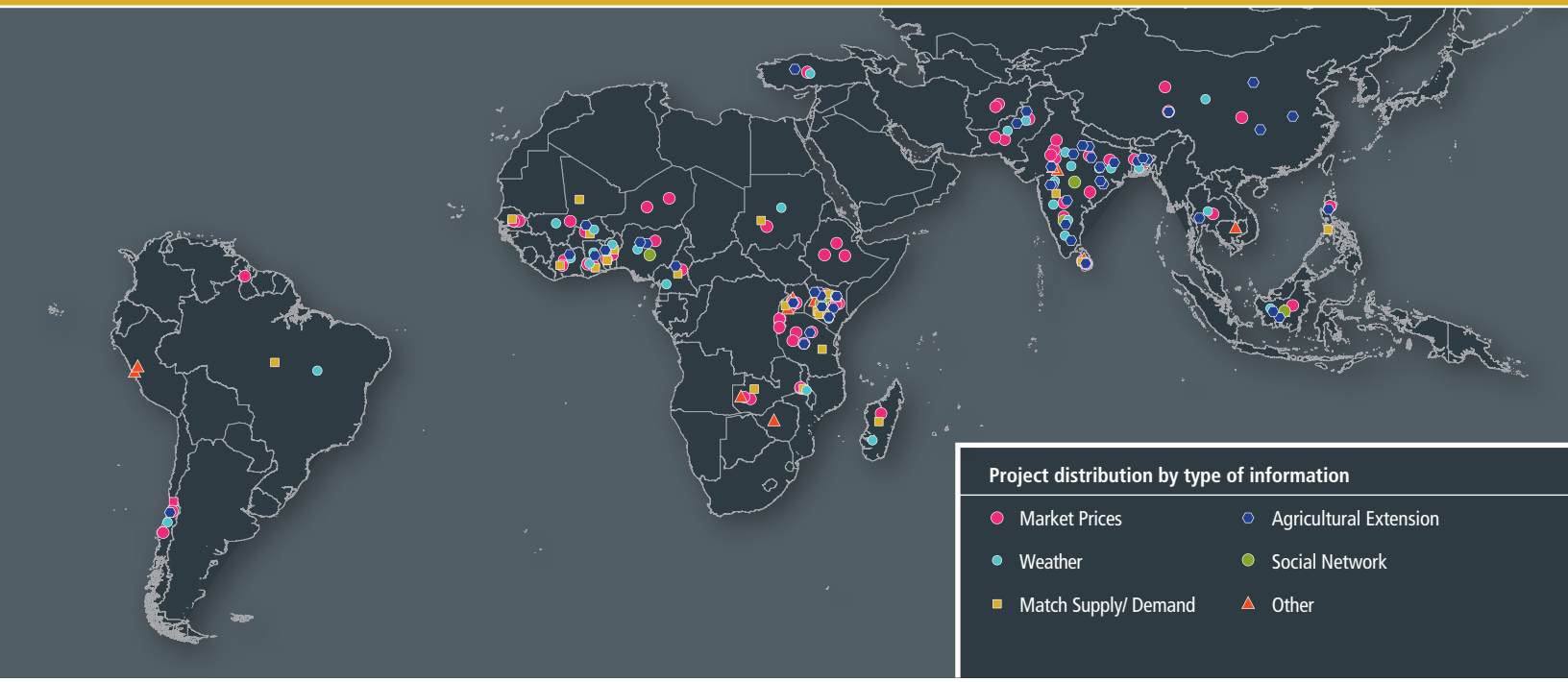
Although far from conclusive or uniform, some studies on the information flow of these technologies have provided a range of estimates for some of the hypothesized effects on smallholders' sale prices and profits. Investigating the impact of price dissemination through radio, for example, Svensson and Yanagizawa found large increases (around 15 percent) in farmgate prices for maize in Uganda.[10] Similarly large effects are suggested by preliminary research in Peru and the Philippines.[11] Others found much smaller or no effects.[12] A more thorough list of such studies is presented in Figure 5.[13]

Finally, information and communication technologies can play a role in reducing the three main constraints faced by traditional extension services in developing countries.[14] First, poor infrastructure makes it difficult and costly to visit remote areas. Second, traditional extension programs usually provide only one-time information to farmers, and the lack of follow-up information and feedback can restrict the long-term benefits of the information.

Of the main potential gains from information use in agricultural markets, the most important is market efficiency.

Finally, traditional extension is plagued by principal-agent and institutional problems, including a lack of accountability among extension agents. Information and communications technologies can overcome these problems by reducing the cost of extension visits, enabling more frequent two-way communication between farmers and agents, and improving the accountability of agents. Aker and Fafchamps have also claimed that in addition to reducing the cost of public information provided through extension services, these technologies can give farmers better access to private information through their own social networks.[15] By increasing communication among farmers, extension agents, and research centers, information and communication technologies can thus facilitate coordination of relevant content among all tree groups.

FIGURE 4 MOBILE PHONE–BASED INFORMATION AND COMMUNICATION TECHNOLOGY PLATFORMS FOR AGRICULTURAL DEVELOPMENT BEING IMPLEMENTED IN 2013



Source: GSMA, "Mobile for Development Intelligence," https://mobiledevelopmentintelligence.com/.

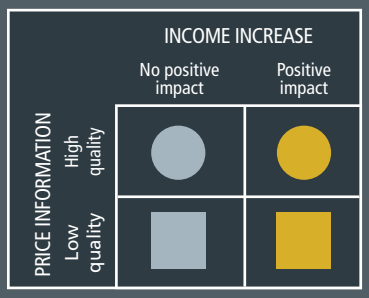
FIGURE 5 IMPACTS OF INFORMATION AND COMMUNICATION TECHNOLOGY IN AGRICULTURE

	PRODUCT	TECHNOLOGY	LOCATION	IMPACT	STUDY
1	Various crops	Public pay phones	Peru	16% increase in prices	Beuermann 2011
2	Various enterprises	Public pay phones	Peru	13% increase in farm income	Chong, Galdo, and Torero 2005
3	Various crops	Cell phones	Peru	11% increase in household consumption	Beuermann, McKelvey, and Vakis 2012
4	Maize, potato, olluco, barley	Cell phones	Peru	No positive impact	Nakasone 2013
5	Green peas, lima beans	Cell phones	Peru	11–13% increase in average prices	Nakasone 2013
6	Various products	SMS	Colombia	No positive impact	Camacho and Conover 2011
7	Various crops	SMS	Colombia	No positive impact	Camacho and Conover 2011
8	Maize	Radio	Uganda	15% increase in prices	Svensson and Yanagizawa 2009
9	Banana	Mobile phone coverage	Uganda	Somewhat positive impact, depending on distance to district center	Muto and Yamano 2009
10	Maize	Mobile phone coverage	Uganda	Somewhat positive impact, depending on distance to district center	Muto and Yamano 2009
11	Various products	Grameen/MTN village phones	Rwanda	No positive impact	Futch and McIntosh 2009
12	Cowpeas	Cell phones	Niger	No positive impact	Aker and Fafchamps 2010
13	Millet	Cell phones	Niger	No positive impact	Aker and Fafchamps 2010
14	Groundnuts	SMS	Ghana	9.7% increase in prices	Courtois and Subervie 2013
15	Maize	SMS	Ghana	12.7% increase in prices	Courtois and Subervie 2013
16	Yams	SMS	Ghana	7% increase in prices	Nyarko et al. 2013
17	Maize, cassava, gari	SMS	Ghana	No positive impact	Nyarko et al. 2013
18	Various crops	Cell phones	Philippines	11–17% increase in per capita consumption	Labonne and Chase 2009
19	Fisheries	Cell phones	Kerala, India	8% increase in fishermen profits	Jensen 2007
20	Soybeans	e-Choupal	Madhya Pradesh, India	1–3% increase in prices (average = 1.6%)	Goyal 2010
21	Potatoes	SMS	West Bengal, India	No positive impact	Mitra et al. 2012
22	Various products	SMS	Maharashtra, India	No positive impact	Fafchamps and Minten 2012
23	Eggs	Cell phones	Bangladesh	Positive impact, not specified	Bayes 2001

Source: Compiled by author. A full list of these studies is found in note 13.
Note: SMS = short message service; MTN = Mobile Telephone Network.

The analysis of the existing research presented in Figure 5 takes into account (1) the level of mobile phone penetration in the country when the interventions in the studies detailed were implemented; (2) the specific characteristic of the commodity in terms of its market value; (3) the specificity or quality of the content being provided to farmers—that is, whether price information is general or specific to the commodity and the markets relevant for the farmer; and (4) the significance of the interventions' impacts (yellow denotes significant; gray, not significant). Given the small number of existing studies and the preliminary nature of several of them, the synthesis presented in Figure 5 is not conclusive; yet several patterns suggest hypotheses to be further researched.

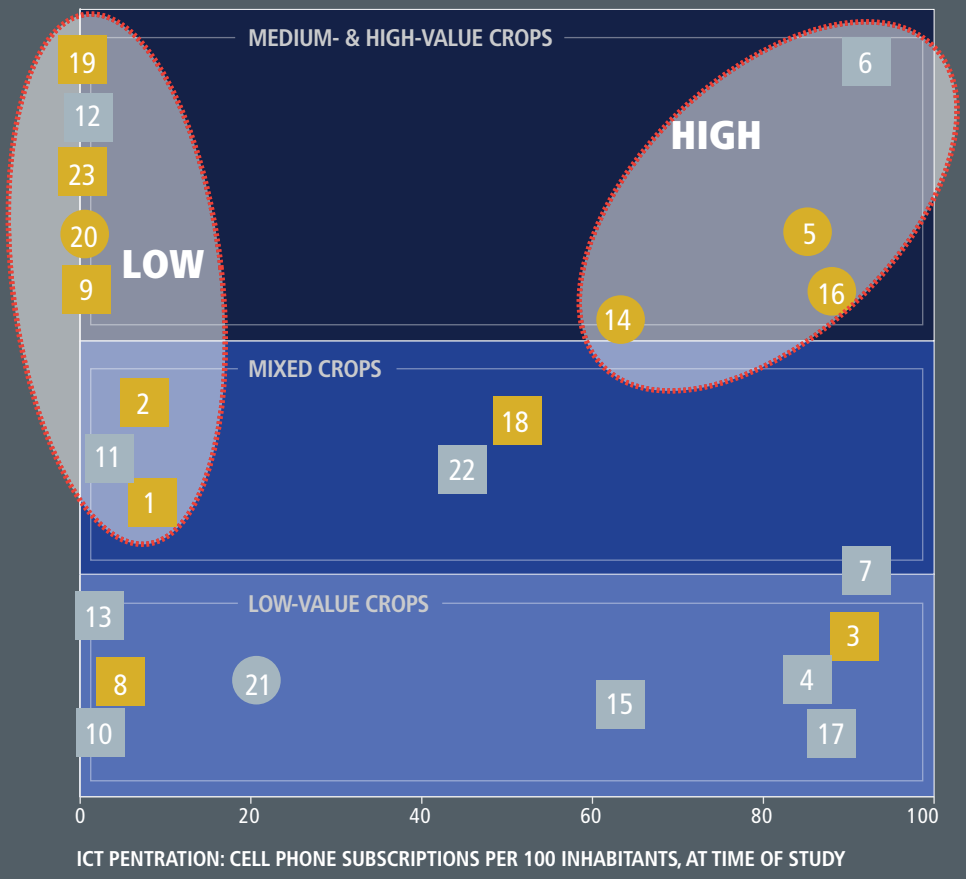
First, the figure shows that the lower the mobile phone penetration at the time of implementation, the more likely the case studies were to return significant findings, especially for mixed medium- and high-value commodities. A partial explanation for this result is that low penetration can be directly related to an important difference in knowledge about prices (or information asymmetry) among farmers; as penetration increases, all farmers might be better able to access the same price information, which has the potential to affect farmers' marketing decisions (such as whether to invest in medium- and high-value crops). Thus, an intervention that increases penetration has the potential to affect agricultural markets by reducing information asymmetry.



WHEN ICT PENETRATION IS LOW, almost any price information—general or specific—tends to have a positive impact on farmer income.

WHEN ICT PENETRATION IS HIGH, price information needs to be more specific to have a positive impact on farmer income, particularly for high-value crops that have a shorter shelf life.

*Numbers in graph correspond to numbered case studies in table.



Second, as the penetration of information and communication technologies (and therefore access to information) increases, the specific content of the information (that is, the usefulness of the information to the farmer) comes to matter. In fact, we see that studies of the impact of information return significant findings only when that information provides specific price information regarding high-value commodities (that is, where timely access to information matters most because of the perishability of the commodity). Fafchamps and Minten assessed the impact of information in regions of India where mobile phone penetration was higher than 40 percent but where only generic information was provided; they found no significant results stemming from that information.[16] On the other hand, other studies show significant results when the information provided was customized to the specific high-value commodities and varieties produced by the farmers studied.[17] One study also suggests that increased information, no matter how specific, for low-value and less perishable commodities is not significant.[18]

MAJOR CONSTRAINTS: THE TWO Cs

The use of information and communication technologies for development is constrained in two major areas: connectivity and content. Regarding connectivity, penetration rates may exaggerate true access to mobile phones. Detailed data from household surveys in developing countries show significant differences between rural and urban access. For example, in Brazil the rural penetration rate is 53.2 percent, whereas the urban

rate is 83.3 percent; in Bolivia, the figures are 18.7 percent and 77.6 percent, respectively; India, 51.2 percent and 76 percent; Malawi, 32.3 percent and 72.7 percent; and Ghana, 29.6 percent and 63.5 percent.[19] Clearly, access to mobile phones varies considerably between countries, and wide gaps in rural connectivity still exist in many developing countries.

One potential explanation for the variation in access between countries and for the access gap in rural areas is the cost of mobile phone service. In many countries even a low-volume basket of mobile service typical of a prepaid phone in a rural area is costly (Figure 6). Figure 7 shows the difference between the cost of a basket of low-volume prepaid service and 5 percent of the income of potential

Mobile Business Applications Link Small Farmers and Markets

CARSTEN FRIEDLAND

Information and communication technologies offer significant potential for connecting small-scale farmers with international food value chains. One example is the African Cashew Initiative, funded by the German Federal Ministry for Economic Cooperation and Development (BMZ) and the Bill & Melinda Gates Foundation, as well as several private companies and public partners. The initiative aims to increase the incomes of 330,000 farmers by US$90 a year by 2015. Before the initiative began training farmers in Good Agricultural Practices, the average net annual income of cashew farmers in the initiative's five project countries was US$144.[1] The initiative also promotes local cashew processing and works to improve market linkages along the value chain.

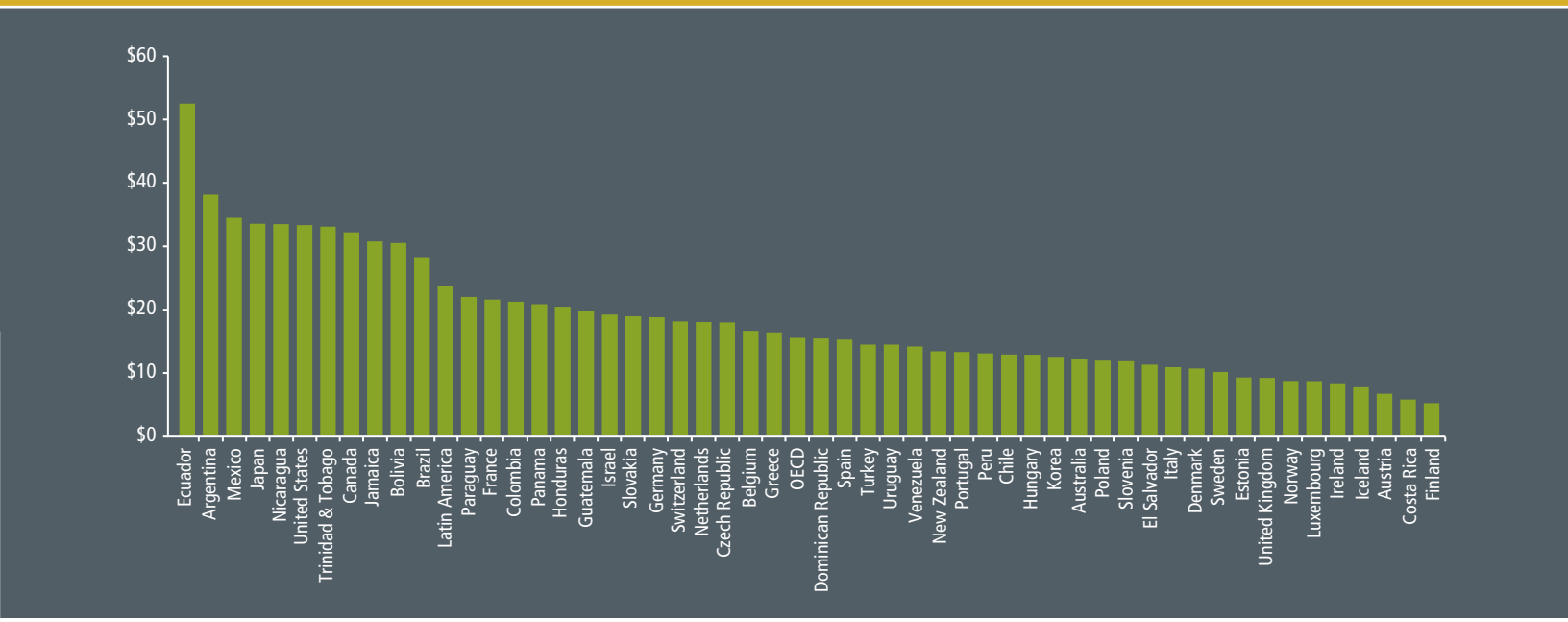
To enable farmers to engage in collaborative business practices in a transparent and sustainable way, the African Cashew Initiative, which is led by GIZ–Deutsche Gesellschaft für internationale Zusammenarbeit GmbH, has joined the software company SAP in a public-private partnership. SAP has developed a system geared toward the digital inclusion of small-scale producers in international value chains.[2] SAP's technologies provide cashew farmer cooperatives and buyers with information from independent cashew farmers. Smartphones are used in the field to record high-volume field transactions—such as farmer registration, prepayment, input supply, grading, purchase, logistics, and payments—and synchronize them in real time. An intuitive management application supports data analysis, facilitates operational field support, and ensures traceability of produce. In a pilot program carried out in Ghana in 2011, adoption rates were promising, with digital transactions totaling 90 percent of the traditional paper-based transactions.[3]

The system is applicable to other agricultural sectors. Since 2011, SAP and its partners have adapted the software for various internationally traded commodities sourced from smallholder farmers. About 20,000 small-scale producers in Burkina Faso, Côte d'Ivoire, Ghana, and Uganda have participated in pilot programs for shea nut, cocoa, cashew, and coffee. Transactions related to the delivery of about 2,000 tons of produce have been recorded digitally. Currently, pilot programs are being integrated with mobile payment systems, allowing for a reduction of cash transactions.

Information and communication technology systems like this one can help producers, producer groups, and buyers run their field activities more effectively and transparently. Producers get access to profitable markets that allow them to maintain and increase their income. By serving as proof of their economic activity, producers' recorded business transactions can improve their creditworthiness and may help them obtain financing for inputs and other investments. The interest shown by local processors, buyers, and multinationals in using the data collected by the system shows that these stakeholders profit from enhanced transparency and reliability when doing business with small-scale producers. Access to data on transactions with individual producers is a prerequisite for more accurate planning and forecasting and for implementation of structured quality assurance processes. Ultimately, such systems could help create more sustainable value chains, remove intermediaries that do not add value, and avoid excessive price fluctuation by allowing for longer-term contracts. This in turn could strengthen local economic activity and improve the well-being of many rural smallholders and their families.

Carsten Friedland is a senior researcher at SAP in Karlsruhe, Germany.

FIGURE 6 INTERNATIONAL COMPARISON OF THE COST OF A LOW-VOLUME BASKET OF MOBILE TRAFFIC, 2013 (US$ PPP)



Source: Hernan Galperin, *Broadband Prices in Latin America and the Caribbean,* Working Paper #15 (Buenos Aires, Argentina: Universidad de San Andrés, 2013).

Notes: PPP = purchasing power parity. Prices include taxes. Equipment and connection costs are not included. The low-volume basket includes 30 outgoing calls and 33 SMSs per month. The following structure of calls is assumed: local to fixed phones (15%), national (7%), mobile in-network (48%), mobile out-of-network (22%), and voice mail (8%). The estimations assume that 48% of calls take place during peak times, 25% in off-peak times, and 27% during the weekends. The following duration of calls is assumed (in minutes): 1.5 for local and national, 1.6 for mobile on-net, 1.4 for mobile off-net, and 0.8 for voice box. The tariffs are prorated according to the market shares of each operating company.

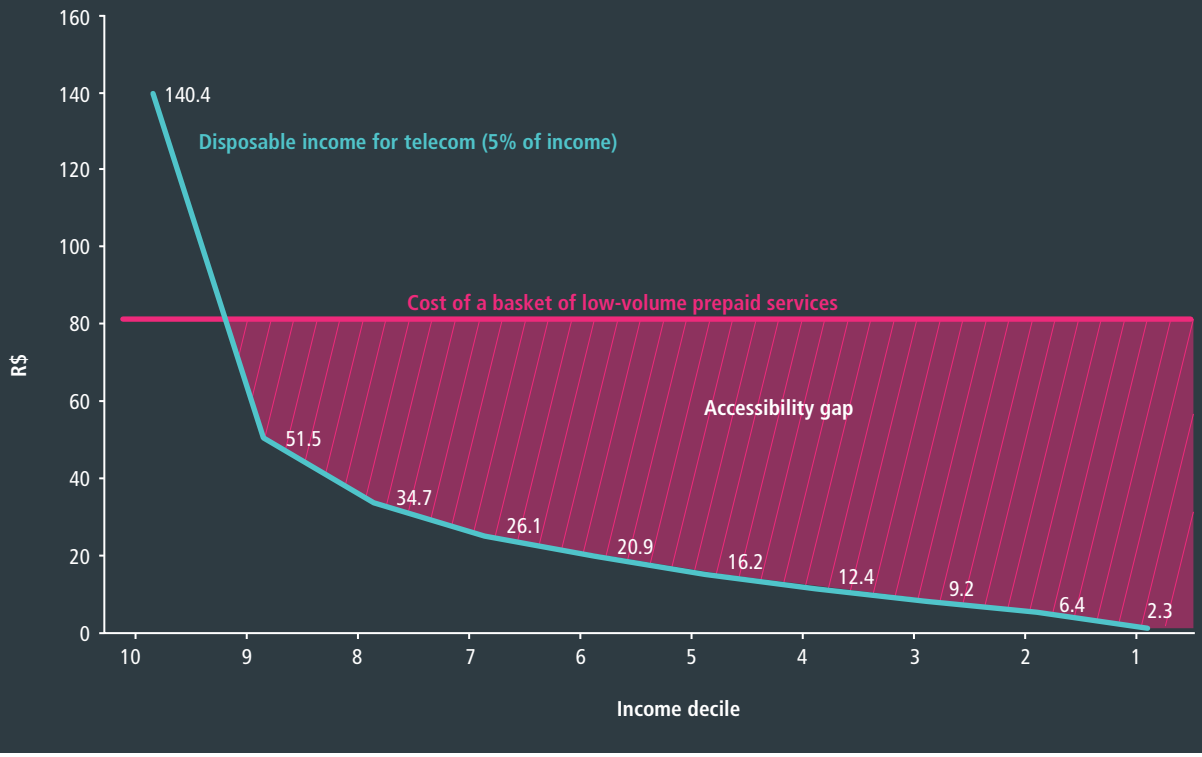
users in each income decile.[20] The results for Brazil show a wide gap between the cost of the service and the payment capacity of potential users. In this case, 90 percent of the population must spend more than 5 percent of its income to buy the basket of mobile services.

The high cost of mobile services seen in some developing countries may stem from the lack of significant competition among service providers or the lack of appropriate regulation. Network industries, such as telephony, are subject to strong economies of scale because significant initial investments are needed to establish operations. As a result governments need strong regulatory authority to ensure that existing infrastructure (normally under monopoly or oligopolistic power) is made available to all competitors at a reasonable access charge.

The second constraint faced by information and communication technologies relates to the relevance of accessible information. If the content provided is not the type of information needed, farmers may be less likely to use these technologies, thereby reducing the technologies' potential impact. The same logic holds true in the use of these technologies for extension. For example, Fafchamps and Minten looked at the effect of using SMS to provide crop advisory tips (offered for one crop chosen by the farmer) and local weather forecasts.[21] Counterintuitively, the authors found no evidence that this information changed cultivation practices or reduced harvest losses.

Other studies highlight how properly targeted, relevant information can affect farmers' production decisions. Cole and Fernando conducted an impact evaluation of the Avaaj Otalo program among cotton farmers in Gujarat, India.[22] This system used voice messages to both push content (providing weekly information on weather and crop conditions) and pull content (through a hotline allowing users to ask for specific advice). Calls from farmers to the hotline were processed by agronomists and answered through voice message. Cole and Fernando randomly selected a group of households to receive the toll-free Avaaj Otalo service. Their

FIGURE 7 DISPOSABLE INCOME FOR TELECOMMUNICATIONS IN BRAZIL (5% OF INCOME) BY INCOME DECILE, 2009



Source: H. Galperin, *Tarifas y Brecha de Asequibilidad de los Servicios de Telefonía Móvil en América Latina y el Caribe* (Lima, Peru: Diálogo Regional sobre Sociedad de la Información, 2009), 22.

Note: R$ = Brazilian real.

preliminary results suggest that households that benefited from Avaaj Otalo shifted to safer pesticides and were more likely to harvest cumin, a high-value cash crop. These findings suggest that the content provided through the voice messages, by being targeted and relevant, was useful for farmers and was thus adopted more willingly.

Similarly, Fu and Akter investigated the impact of a program called the Knowledge Help Extension Technology Initiative (KHETI) in Madhya Pradesh, India.[23] This initiative operates through agricultural specialists who travel from village to village with special mobile phones. These phones are able to record short dialogue strips (SDSs), or short videos, that depict a particular problem faced by a farmer. The SDSs are then sent to scientists, who determine solutions for each case, and the solutions are passed back to the farmers. Fu and Akter argued that those in the KHETI group increased their awareness and knowledge of extension services compared with those in a control group.[24] The authors also found that beneficiaries perceive this initiative to be more useful, faster, and of better quality than other services. It should be noted, however, that no increase in adoption of the solutions provided by this initiative has been identified, which implies that there have been no increases in farmer productivity and income.

These studies highlight the heterogeneity of extension projects—including one-way versus two-way communication between farmers and agricultural specialists, SMS versus voice transmission of advice,[25] and oral description versus visual representation of problems. Because most agricultural extension work being conducted through information and communication technologies is fairly recent, however, we still lack adequate evidence regarding which projects work effectively.

THE WAY FORWARD

The accelerating adoption of information and communication technologies around the world provides a significant opportunity. This is particularly true of cellular phone technology, which has increased rapidly in developing countries (though costs still prohibit wider adoption, and there still remains an important gap between access in urban and rural areas). Better access to price information can allow farmers to plan more effectively how much to plant each season, as well as how much and what type of investments could be profitable based on supply-and-demand fundamentals. These technologies can both promote learning and provide better access to price information and improved technology. All of these impacts could potentially affect agricultural productivity and income-generating opportunities for the poor.

Taking advantage of these opportunities, however, depends not only on connectivity, but also on relevant content provided in accessible and useful forms. These two Cs (connectivity and content) should progress simultaneously. Even though the cost of information and communication technologies is falling rapidly, there is still a need to continue improving both access to and use of new technologies in the poorest areas. In some countries subsidies have been implemented in response to this problem, with the goal of improving access to telecommunications for rural households and ensuring that poor people pay no more than their wealthier urban counterparts for this access. The economic rationale for subsidies is that these technologies have positive spillover benefits for people's consumption and production and create not only network externalities (that is, a change in the benefit, or surplus, that an agent derives from a good when the number of other agents consuming the same kind of good changes) but also the potential for economies of scale. The main problem with such schemes, however, is that they can be financially unsustainable.

One solution, adopted by telecommunication investment funds in Chile and Peru, is to use a small percentage of the gross operating revenues of existing private operators to pay for subsidies.[26] Other countries should consider this option. In addition, alternative technologies should be further explored. Broadband technology, for instance, has the potential to provide access to both data and voice services and thus increase competition in the delivery of services. A dual broadband strategy, promoting both the deployment of wireless broadband networks and the adoption of voice telephony applications targeted to low-income users, is one approach that should be carefully assessed, including the appropriate roles of the public and private sectors.

Content is also crucial, especially where cellular phone penetration is high. The existing evidence, though based on a small number of cases, suggests that content quality matters if information and communication technologies are to be useful for development. Thus, going forward, there is a clear need to continue assessing the impact of the quality of information. In addition, many aspects of agricultural information constitute a public good, and governments need to invest in providing the best possible information regarding not only prices for different markets, produce varieties, and produce quality but also production technologies and other agronomic information. If these investments are not made, the potential impact of these technologies could be limited, especially for high-value commodities and markets. We need innovative ways to bring together the public and private sectors to ensure that the two Cs are addressed as a whole. ■