How Mobile Phones Contribute to Growth of Small Farmers? Evidence from India

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Abstract

Rapid growth of mobile telephony and the introduction of mobile-enabled information services provide ways to improve information dissemination to the knowledge intensive agriculture sector and also helps to overcome information asymmetry existing among the group of farmers. It also helps, at least partially, to bridge the gap between the availability and delivery of agricultural inputs and agriculture infrastructure. This paper explores further on this topic and provides evidence to show how mobile phones and mobile-enabled agricultural services have impacted the farmers. As mobile penetration continues to increase among farming communities and information services and to adapt and proliferate, the scope exists for a much greater rural productivity impact in the future. To leverage the full potential of information dissemination enabled by mobile telephony along with supporting infrastructure and capacity building amongst farmers it is essential to ensure the quality of information, its timeliness and trustworthiness.

Keywords: ICT for development, agriculture extension services, mobile phones based agri-services, farmers in India, agricultural productivity and growth
JEL: O30, Q01, Q16, Q18

1 Introduction

The challenge for the Indian government and policy makers is to regain the dynamism in agricultural sector as was evident in the 1970s during the era of green revolution. A major dilemma in the present situation – rising food prices and an ever growing population – is to strike a balance between policies for food security and policies to improve income levels of farmers. With agriculture being constrained by the availability of land, improving productivity remains a crucial factor for the future of India's food security.

Research, extension, literacy and infrastructure have been identified as the most important sources of growth in productivity in literature (MITTAL and KUMAR, 2000;

KUMAR and ROSEGRANT, 1994; EVENSON et al., 1999; FAN et al., 1999). The development of markets improves input-output market interface and this is important for productivity growth. In agriculture, education and access to knowledge creates conditions that enable farmers to acquire and use information for decision making regarding allocative and technical matters effectively. This leads to growth in the adoption of technology; the use of modern inputs like machines and fertilizers improves yield.

The World Development Report 2008 (WORLD BANK, 2007) emphasized that agricultural extension plays an important role in agricultural development and in promoting sustainable, inclusive and pro-poor economic development. Also access to ICT can have a tremendous positive impact on sustainable development and poverty reduction (TORERO and BRAUN, 2006). Extension services help to disseminate information regarding the technology relevant for their geographical areas and cropping system and generate awareness among farmers by recommending the appropriate quantity and quality of inputs and their timely use. It also educates farmers about good agricultural and crop management practices. But recent stagnation and in some regions total breakdown of extension services has led to large gaps in the farm yield and crop productivity. Insufficient extension services and poor access to information has impeded the transfer of technology at the farm level. The results of the situation assessment survey of farmers conducted by the National Sample Survey organization (NSSO, 2005), GoI, reveal that only 40% of the farmer households have access to information about the new farming technology. Information needs are growing rapidly with the introduction of modern technology, hybrid seeds and changing climatic conditions. Thus, farmers often find that their traditional knowledge, experience and guesswork to make decisions for day-to-day activities are not very effective in changing circumstances. The high cost of delivering information through face-to-face interaction, crumbling extension services and poor market information has paved the way for the use of modern information and communication technology (ICT) like mobile phones in disseminating agricultural information to targeted farmers.

2 Objective of the Research

In India, increased penetration of mobile handsets, large number of potential users, increased spread of communication, and low cost of usage lead to growth of large number of mobile based information delivery models for the agricultural sector. The NSSO survey of Indian farmers show that farmers voiced the need to improve the quality, reliability and timeliness of information delivered to them. Mobile phones alone cannot play this role though they can be more appropriate to deliver content for customized, timely information delivery if the models are developed appropriately.

The broad categories of information required by farmers, irrespective of their location and crops can be categorized as know-how, which helps a farmer with fundamental information such as what to plant and which seed varieties to use; contextual information such as weather, best practice for cultivation in the locality; and market information such as prices, demand indicators, and logistical information (MITTAL et al., 2010). Of these broad categories, farmers' specific information needs vary based on the cropping system, soil type and local weather.

With this background the objective of this paper is to provide evidence on how mobile phones are being used to meet the information needs of farmers, and on the impact mobile phones and mobile phone based services have on farm income and cost of production in India. The overall goal or expected outcome of this paper is to see the potential of modern ICT to improve incomes of small holders and improve their productivity. It is expected that modern ICT can play a role in bridging the information gap and reduce the information asymmetry that exists between the large and the small farmer by making the content precise, timely and localized and thus will enhance the dissemination of knowledge and information on technologies, inputs, markets and prices. This will enable the adoption of improved technologies, seed varieties, and farming practices.

The results presented in this paper are based on focus group discussions and the interactions held with farmers in a survey conducted in Punjab, Haryana, Uttar Pradesh, Bihar and west Bengal during February 2011 to April 2011. The states covered in these surveys are the major food belly of India. These results are supported by a series of field investigations conducted from August 2008 to November 2008 and follow up telephonic interaction in 2009 in the states of Uttar Pradesh, Maharashtra and Rajasthan. This is supplemented by evidence from literature on India and other developing countries. These visits comprised of interactions with farmers, labourers, traders, commission agents, non-profit organisations and businesses involved in the agricultural sector. The focus group surveys of 2008 were conducted with around 187 farmers of whom 152 were small farmers. In the 2011 survey we covered around 1200 farmers in five states of which 64% of farmers have small or marginal land holdings. Our focus group discussions and individual interviews covered farmers who had mobile-phones but many of them did not have access to any of the mobile-enabled agricultural information services.

Table 1. Socio-economic and ICT indicator of the surveyed states

States	Population (millions)	Per capita Income (Rs.)*	Per cent share of agriculture in total GSDP	Literacy rate per 100 person	Mobile subscriber per 100 rural person	Fixed lines per 100 rural person	Internet subscriber per 100 person
Bihar	103.80	14,654	18.29	63.82	21.46	0.4	0.26
Haryana	25.35	77,878	18.13	76.64	50.04	1.29	1.56
Maharashtra	112.37	37.501	8.90	82.91	44.76	1.31	3.44
Punjab	27.70	61,035	28.53	76.68	53.93	2.99	3.24
Rajasthan	68.62	28,885	18.36	67.06	37.99	0.81	1.12
Uttar Pradesh	199.58	22,558	23.20	69.72	26.26	0.32	0.05
West Bengal	91.35	36,322	17.00	77.08	37.73	0.56	1.19
Source and year of data	Census of India, 2011	CSO, 2010	CSO, 2010	Census of India, 2011	TRAI, 2011	TRAI, 2011	TRAI, 2011

* at current price

Note: GSDP: Gross state domestic product, CSO: Central Statistical Organisation, Government of India (GoI), TRAI: Telecom Regulatory Authority of India, GoI

3 Traditional and Modern ICT's

The application of ICT in agriculture is not a new concept. Studies have shown that most farmers had access to a variety traditional information sources (TV, radio, newspapers, other farmers, government agricultural extension services, traders, input dealers, seed companies and relatives), which they regularly access for agricultural information (NSSO, 2005; MITTAL et al., 2010; SARAVANA, 2011). These traditional ICT's have been an important tool since past several decades to disseminate scientific and technical agricultural knowledge to farmers and also leading to improved adoption of technologies. They played an important role during the green revolution in 1970's and 1980's (SULAIMAN et al., 2011). In late 1950's and early 1960's radio broadcasts were initiated (PURUSHOTHAMAN et al., 2003; KAMESWARI et al., 2011). Krishi Darshan was the first television based programme for framers which started in 1960's on the national channel of India. Various new television and radio based agriculture programs were launched in 1990's and farmers' were also using television and radio, still the empirical impact of these services on farm household income is not known (GLENDENNING et al., 2010).

The common feature of the traditional ICT's was that they were purely the one way mode of transmitting information (MITTAL and TRIPATHI, 2009). Although slowly and gradually the traditional ICT's started disseminating information in localized language, but since their transmission was for a large mass of farmers spread over various districts and villages, the content was not specific to specific needs and was generic for major new innovations and technologies. Evolution of community radio was a step forward where for each village or a group of villages dedicated radio services and transmissions were initiated. In India tele-centers were also introduced through government initiated programs (table 2), but due to constraints like poor penetration of landline phones and not regular access to the expert through these tele-centers led to poor performances of these initiatives (MITTAL, 2012). Although later developments like live or phone in programs could improve the communication (SULAIMAN et al., 2011).

Table 2. Selected modern ICT models in India and their evolution over years

Tele-centre based	**Internet based**	**Video based**
– Kissan Call Centers, GOI, 2004 – BSNL Help line	– Village Knowledge Centres, 1998 – ITC e-chaupal, 1999 – E-sagu, 2004	– Digital Green, 2009
Mobile - SMS based	**Mobile based application**	**Mobile - voice message based**
– Reuters Market Light (RML), 2007 – Warna Unwired - Microsoft, 2007 – KVK's- NAIP, 2009 – Kisan Sanchar, 2010	– Fisher Friend - MSSRF, 2008 – Nokia - Life tools, 2009 – Tata - M Krishi, 2009	– IFFCO Kisan Sanchar Limited (IKSL), 2007

Source: compiled by authors

The Indian extension system has undergone reforms since late 1990s and experienced major conceptual, structural, and institutional change (RAABE, 2008). These changes were undertaken to improve the efficiency, effectiveness and timeliness of services. These reforms included the development of public private partnership to provide extension services and strengthening the linkages between researchers in laboratories and farmers in the field. Modern ICT-based extension services provide an opportunity to strengthen these linkages. Projects like Agricultural Technology Management Agency (ATMA), e-sagu and e-choupal gave the initial thrust followed by introduction of mobile phones and web portals to deliver information and technology to farmers at wider scale.

Although public investments in agriculture sector-based ICT initiatives are low, but with great interest from the private sector, a number of such initiatives are being developed and implemented in India. The new initiatives include community radio, SMS and voice-based cellular telephony, internet through tele-centers, information kiosks, village knowledge centers, multipurpose community centers etc. In India, some of the very initial models using modern techniques were the *kisan* call centers and village knowledge centers that were based on landlines and internet-based computer centers in villages. These were initiated mainly by the government or non government organizations (NGOs). The modern communication modes evolved and are still evolving as shown in table 2. Slowly but gradually, technical innovations are being incorporated in service delivery systems. An interesting fact is that no new system is a replacement for an old system; it is an add-on to the prevailing structure of extension services, sometimes to improve efficiency and sometimes to improve reach.

There is little doubt that information and knowledge can affect poverty reduction and can be a driver of economic growth, but empirical evidence on this is still missing (BHAVNANI et al., 2008). It is often seen that remote regions are high in poverty and increased connectivity in these regions is likely to reduce poverty (MUTO and YAMANO, 2008). Various other factors also play a role here, individuals benefit from community-based phones and community participation even if individual household adoption is not there. The hard task of mobilizing small farmers to participate in this system of efficient and effective information dissemination still remains. Mobile phone use has yet to demonstrate its role in the efficient provision of public goods and services, particularly in low-income countries. But some evidence is available from India which is also supported by similar evidence in some other developing countries like Africa and Sri Lanka. This is presented in next section of this paper.

The conceptual framework on transmission of information from the service provider to the user is presented by HEEKS (2002, 2005) which is later modified and presented in an IFPRI paper (GLENDENNING and FICARELLI, 2012). The content of the information to be transmitted is formulated, customized, written or recorded in local language and then transmitted to farmers on their mobile phones. The transmission mechanism requires setting up of an IT infrastructure, content sourcing, creating and managing, and creating a help line for a two-way communication. The perceived benefits of various information vary according to the region, crop, infrastructure and socio economic conditions of the farmers, and necessary condition for these information to have impact is that the farmers acts on the information. From the literature various impacts are discussed in detail in section 4 of this paper but overall it is expected that weather information about likelihood of rainfall, temperature, etc. will enable framers to make informed decision in choice of seed varieties, decide on timing of sowing and harvesting. Information about rainfall helps in taking timely decision on time of application of

inputs like fertilizers, pesticides, weedicides. Information on occurance of rainfall and other climatic uncertainties help in organizing better storage facilities. Agronomic information and information on farm practices has the likelihood of improved adoption of technology, efficient resource management and better yields. Overall reduced cost of production, reduced loss of inputs and better planning reduces production risk. Information on inputs availability, types and prices lead to better use of inputs, getting better connected to input markets leading to improved yields and reduced spending on poor quality inputs. With output market information, farmers are better informed about markets to sell produce, prevailing market prices and quantity demanded in the market. Thus, they can make informed decisions to sell produce at the right price and right time. This helps reducing distress sales by farmers due to market supply fluctuations. Overall it reduces market inefficiencies, search cost and transaction cost and improves price realization.

These information are also otherwise available through other ICT modes and extension system, but the emphasis is that localised, customised and timely information, accessed by farmer personally in a targeted manner on his mobile phone, enables him to make better informed decisions.

4 Evidences from India

The World Bank's independent evaluation group made observations that – (1) farmers who regularly connect with extension staff are more likely to adopt technology sooner. (2) It is a fact that the progressive farmers get connected to extension agents faster than other farmers. (3) The technology that provides returns quickly is accepted quickly and its use is more wide spread. If these three observations are taken as facts, modern ICT can be used as an efficient tool to get non-progressive farmers connected to extension information and to make them adopt technology faster. ICT play an important role in adoption of technologies that are in an early stage of adoption like no tillage and the GM technology revolution (FISCHER et al., 2009). The contribution of modern ICT is felt in all stages of the agriculture cycle and also depends on the kind of information delivered. The impact of this information can be classified in terms of both quantifiable (increase in income, improved yield etc.) and non-quantifiable terms (social benefits of improved communications, information about education and health etc.) (BHATNAGAR, 2008; MITTAL et al., 2010).

During the surveys (both 2008 and 2011), most of the farmers reported that they use mobile phones mainly for social communication but later they have increasingly started using it to get connected with people like traders and other farmers who have agricultural activities related information. Most of the small farmers reported that there

is some increase in convenience and cost savings from using their mobile phones as basic communication devices to seek information, such as input availability or on market prices.

Some other benefits which farmers listed were that farmers benefited from improved access to information including seed variety selection, best cultivation practices, protection from weather-related damage and handling plant disease. The 2011 survey had about 34.63% of farmers who experienced an increase in yields due to the availability of this information. Of these the highest yield gains were observed by farmers in Punjab (49.2%) and Haryana (42.9%) (table 3). While in Bihar it was 21.1% of farmers using mobile phones reporting yield gains, 29.4% in Uttar Pradesh and 34.01% of such farmers in West Bengal.

Table 3. Benefits of mobile based information

States	Percent of farmers using mobile phone for agricultural information	Get better connected to markets	Getting better prices	Increasing yield
Bihar	51	99.2	65.9	21.1
Haryana	65	99.4	79.5	42.9
Punjab	26	77.8	82.5	49.2
Uttar Pradesh	45	69.7	69.7	29.4
West Bengal	17	65.9	48.8	34.1
Total	41	87.2	71.7	34.6

Note: This percent of farmers is from the 41% of farmers, who are using mobile phone to access agricultural information. Farmers have multiple responses. This is being rigorously evaluated under the ongoing research to measure the actual effect of mobile phones on income and welfare of households.

Source: CIMMYT Survey (2011)

A limitation of this analysis is that it is difficult to compare farmers that use mobile phones for accessing agricultural information and those that do not. In order to do such a comparative analysis, careful formation of on randomised control trials needs to be developed. Since most of the farmers access information from multiple sources of information (NSSO, 2005: MITTAL et al., 2010; MITTAL et al., 2012), sometimes it becomes difficult to distinguish the pure effect of the use of mobile phone services. Mobil phone based information services have not yet penetrated or become popular with the majority of farmers due either to their cost or dissatisfaction with the relevance of content. But farmers who are dedicatedly using these services have been

interviewed to respond on specific questions; the results are presented in table 3 and in this section supported by evidences from other studies.

4.1 Better Connectivity to Markets and Price Realization

One of the perceived benefits of modern ICT is greater access to information on markets and prices. Price information has an impact by improving the bargaining capability of farmers with traders, better price realization and reduction in arbitrage, wastage or spoilage.

The survey of farmers in 2011 in states of India showed that with access to information through mobile phone they are now better connected to the markets and mobile phones have helped them to get better prices too. 87.2% of the farmers feel they are better connected to the markets after the introduction of mobile phones while 71.7% of the farmers have now better access to the price information (table 3). From the focus group discussions with farmers in 2008 it was found that in Maharashtra farmers who were accessing market information through a prescribed information source were better connected to markets than the ones in Uttar Pradesh and Rajasthan, who were dependent on the scattered market information not from any specialized market information source. Maharashtra farmers reportedly benefited in terms of better price realisation and increased revenues through better adjustment of supply to market demand. These farmers used information on market demand predictions to adjust the quantity of supply they harvested and took to market during a given period. Market information influenced farmers to alter where and when they sold their crop in order to maximise revenues and, in some cases, provided ammunition to farmers to negotiate better pricing terms from local traders.

FAFCHAMPS and MINTEN'S (2011) paper estimated the benefit of information on markets and whether being delivered to farmers through short text messages (SMS) over mobile phones. They used the case of the service provider, Reuters Market Light (RML), in Maharashtra, India. The study found that farmers use this information for decision- making, but found no statistically significant effect of the intervention on the price received by farmers or reduction in crop wastage due to climatic factors. The study concluded this from a controlled, randomized experiment in 100 villages of Maharashtra. These results are contrary to other literature on these issues, which show a potential impact on price realization and reduction of wastage (JENSEN, 2007; ABRAHAM, 2007; MITTAL et al., 2010; AKER, 2008; GOYAL, 2010).

Other studies like AKER (2008), MUTO and YAMANO (2009) demonstrated the positive gains in price due to the introduction of mobile phones, but this was more evident in the case of commodities or regions where price information asymmetry was very high

or the markets were not well developed for specific high-value commodities. The expansion of mobile phone networks and increase in mobile-density in Uganda has enabled higher market participation by farmers producing perishable crops like banana and has helped them to realize higher prices by almost 20% by reducing the information asymmetry that existed between farmers and traders (MUTO and YAMANO, 2009). Similar results were attained by AKER and FAFCHAMPS (2010) that the introduction of mobile telephony reduced producer price dispersion for cowpeas by 6%.

The results from these studies do emphasize that the introduction of mobile telephony or mobile-enabled agriculture information services have a higher impact in regions which are poorer and are remote from markets. This is so because the initial returns to the introduction of mobile based information services are larger in the regions which have higher information gaps. This might be a reason why FAFCHAMPS and MINTEN (2011) in their paper, which had Maharashtra, a developed state, as their study area, found that the services provided by RML did not have much of an impact. But it is also true that in comparison to the rich and wealthier farmers the poor farmers are not able to maximize their benefits with the availability of information (JENSEN, 2007; MITTAL et al., 2010; MITTAL and TRIPATHI, 2009; KAMESWARI et al., 2011; SOUTER et al., 2005). It is worth examining the relevance and utility of the introduction of mobile phone information services in regions that have a lesser degree of information asymmetry and consequently stand to gain less from modern ICT.

The survey of 2008 also noted that the potential benefits of information flow have been obtained mainly by large farmers in the various states of India. This is so, because the small farmers, despite access to information, have not succeeded in overcoming constraints resulting from poor access to capital, poor infrastructure and lack of access to markets. The 2011 survey (table 4) also highlighted similar results where almost 90.48% of the large farmers who were using mobile phones could get a better price for their commodities while only 63% of marginal farmers and 71.3% of small farmers could benefit from the price information. In table 4 it is interesting to note that although the share of farmers perceiving price gains differed for different farm sizes, the number of farmers perceiving better market connectivity is very similar and high for almost all farm sizes. This finding re-emphasises the fact that although with availability of information on prices and markets made available to the farmers, even the small farmers are able to access markets and are better connected to markets, but when it comes to count it in terms of actual prize realization it is only the relatively large size farmers who gain the most. This is mainly because of various constraints faced by the farmers like poor bargaining ability, credit 'bondedness' to middle men (MITTAL et al., 2010) and several other factors as explained in section 4.3 of this paper.

Table 4. Benefits of mobile phones based on land size

Land size	Percent of farmers using mobile phone	Getting connected to market	Getting better price
Marginal (less than 2.47 acres)	26.83	72.65	63.25
Small (2.47-4.94 acres)	39.61	90.91	71.33
Semi medium (4.94-9.88 acres)	52.74	91.20	72.00
Medium (9.88-24.7 acres)	63.7	93.02	79.07
Large (more than 24.7 acres)	67.74	95.24	90.48
Total	41.00	87.20	71.75

Note: This percent of farmers is from the total farmers who are using mobile phone to access agricultural information. Farmers have multiple responses. This is being rigorously evaluated under the ongoing research to measure the actual effect of mobile phones on income and welfare of households.

Source: CIMMYT Survey (2011)

4.2 Reduced Wastage and Transaction and Search Costs

JENSEN (2007) found that the introduction of mobile phones decreased price dispersion and wastage by facilitating the spread of information for fishermen in Kerala. This made markets more efficient and enhanced both consumer and producer welfare. Mobiles allow fishermen, particularly the more prosperous ones, to get timely price information and decide on the best place to land and sell their daily catch. ABRAHAM (2007), who also looked at Kerala fishermen, found that the widespread use of mobile phones increased the efficiency of markets by decreasing risk and uncertainty, although it noted that realizing potential efficiencies depended on easy access to capital. Using mobile phones while at sea, fishermen are able to respond quickly to market demand and prevent wastage from the catch which was a common occurrence before the application of mobile phones. Mobile phones help co-ordinate supply and demand, enabling traders and transporters to take advantage of the free flow of price information by catering to demand in undersupplied markets.

The logical starting point to understand the total information related transaction costs faced by the farmer is to understand the demand for information at each point of exchange by disaggregating the agricultural value chain into a series of activities. An integrated mobile platform for knowledge and information can help in strengthening the value chain and help the farmer gain by reducing transaction costs. The survey in 2008 didn't show much evidence on how the transaction coast is reduced but there were reported incidences during the focus group discussions that better connectivity

and communication has helped to reduce the transaction time especially in times of breakdown of transportation or delays in deliveries of commodities to the markets. Also farmers have reported that their search cost of inputs has definitely reduced, as now they are well connected to input dealers for purchase of inputs. 2011 survey (table 3) showed that only 25.8% of the farmers could actually quantify the benefits of using mobile phones in terms of saving time or reducing search cost.

But literature shows that the use of mobile phones did lead to savings in transaction costs. The adoption of mobile telephony by farmers and agricultural traders in Ghana has helped them reduce both their transportation and transaction costs. The members associated with trade networks, with the help of modern telecommunication modes were able to run their activities in a better organized, more efficient and cost effective manner. This revolution of mobile telecommunication in Ghana did help reduce information asymmetry (OVERA, 2006).

In most developing countries, information search costs form a significant part (to the tune of 11%) of the total cost incurred by farmers during the agricultural cycle, starting from the decision to sow to marketing of produce (BHATNAGAR, 2008). Mobile phone usage by farmers can reduce information search costs, thereby dramatically lowering transaction costs and enabling greater farmer participation in commercial agriculture (DE SILVA and RATNADIWAKARA, 2008).

AKER and MBITI'S study (2010) identified mobile phones as a new search technology that has reduced the search cost for farmers by almost 50% in Niger. One of the advantages of mobile telephony is that instead of being passive recipients of information through television, radio or newspapers, users have the advantage of interaction and access to multiple sources of information. This helps them assess the quality of the information received.

4.3 Constraints on Realizing Full Benefits of Mobile Phones

Overall ICT's have not yet been able to create an impact as expected, possibly because there are challenges in putting the new knowledge into use that are basically supported by traditional communication tools (SULAIMAN et al., 2011). The effectiveness of ICT in passing on information to farmers, particularly small landholders, holds the key to its successful utilization as a complementary information dissemination mechanism for extension services (MITTAL, 2012). In order to make these models meet the small farmer's needs and requirements, we need constantly to add values to these models to make them dynamic, and thus in this section we list the constraints that need to be investigated in order to improve the scope of modern ICT to meet the objective of better targeted information delivery.

BHAVNANI et al. (2008) point out that despite the increasing demand for relevant and timely agricultural information in rural areas, there remains a digital divide that has prevented the percolation of benefits to the poor. The main beneficiaries of the ICT revolution have been population segments with and in areas where infrastructure is developed; the poor and those living in distant areas have been excluded. Mobile phones can act as a remedy because of its wide reach and low cost of delivering information. It also enjoys the advantage of greater flexibility since it enables information dissemination through both voice and text messages. Despite this, there are certain factors that constrain the full utilization of the potential of uses of mobile phones by the farmers mainly the small farmers. Although the 2008 and 2011 surveys found evidence that mobile phones are being used in ways that contribute to productivity improvement, reduction in cost, better price realization, the results need to be evaluated in greater depth by conducting impact assessment.

During the surveys it is found that there is a need to establish supporting infrastructure and build farmers' capacity to be able to utilize this information and to enable them to realize the full development potential that information delivery through mobile phones has to offer. Some of such factors include availability of quality seed, pesticides and fertilizers; availability of labor, access to infrastructure like irrigation, electricity, and soil and water testing infrastructure (table 5). Almost 46.9% of the farmers said that the biggest constraint they face to improve their productivity is lack of access to any extension service or credible information source.

Table 5. Constraints faced by farmers in accessing the required information

Constraint in accessing information	Number of farmers	Percent of farmers
Poor extension facility	562.58	46.87
Inappropriate availability of quality inputs (seed, pesticides and fertilisers)	226.16	18.84
Poor access to electricity and irrigation facility	122.24	10.18
Shortage of labour	66.98	5.58
Poor or no access to soil and water testing facility	66.19	5.55

Note: Farmers have multiple responses. Number of farmers are weighted by the number of constraints highlighted by them, with three being maximum number of constraints. e.g. If a farmer has listed three constraints then each constraint is given a weight of 0.33 and if one farmer has listed only one constraint as the most important then that is given a weight as 1.

Source: CIMMYT Survey (2011)

The investment requirements to build up the kind of ICT infrastructure that will be able to deliver the information to farmers are huge. Capacity building and awareness

campaigns are needed to win farmers' trust in the system and to motivate them to shift to new modes of accessing information (MITTAL et al., 2010; LOKANATHAN and DE SILVA, 2010). Another constraint on the greater use of ICT in agriculture is the scattered nature of ICT initiatives. This leads to low adoption and usage of support tools developed for small-scale agriculture because extension services do not reach the targeted population on time (MUNYUA, 2007). This was documented in the context of Africa, but is also true for India.

The basic parameters of any mobile-based information delivery system are that it should have efficiency in delivery, relevance in content, and a firmed-up content calendar for timely delivery (MITTAL, 2012). GLENDENNING and FICARELLI (2012) emphasize that although ICT initiatives try to provide locally relevant content to farmers which help in reducing the expert-farmer gap and all efforts are made to make content relevant, accessible and sourced from reliable knowledge sources, yet there is a gap in the feedback and involvement of users to improve content relevance. The modern ICT models still lack appropriate network linkages with research institutes, farmers and other knowledge banks which are a possible source of appropriate content for the customized, timely information (MITTAL, 2012). The development of content is a continuous process and these limitations might create the issue of sustainability in delivery of appropriate content.

Although on all the above mentioned limitations and constraints continuous efforts are being made to improve, but besides this there are debates and issues on if delivering information though SMS is preferred over the voice messages or vice versa. For text SMS there are issues converting the content in local language, creating the content in the space constraint of 160 characters, compatibility of local language with the farmer's handsets and that of literacy too. While the voice messages might not have these constraints but they are more costly to deliver, efficiency of receiving the messages at pre defined time is poor and there is a cost of retrieving the information in the message (MITTAL et al., 2010; AKER, 2010; MITTAL, 2012).

These constraints are the opportunities that the service provides and extension agencies along with the mobile phone technology producers and policy makers can work on to strengthen the information delivery to the farmers to improve agricultural productivity and farmers incomes.

5 Conclusion and Summary

Among modern ICT modes, mobile telephony has been most recent and widely accepted mode of delivering information not only in India but also in other South Asian and African countries. Increasing mobile phone and mobile phone based

services enhances the availability to knowledge and information and will further help in improving awareness, education, better adoption of technology, better health and efficiency, reduced transaction costs, better market efficiencies, etc. These in turn will catalyze the rural sector development and economic growth.

FISCHER et al. (2009) emphasize that ICT has great potential and should be given the same importance as biotechnology revolution. In the context of India, the impact of mobiles as a mode of providing information for farming will depend on the how mobile networks are able to link the farmers to the market information in a timely and accurate manner.

This paper provided evidence on the role of mobile phones in reducing information search costs and asymmetries and increasing market efficiencies. The use of mobile phones has been found to encourage poor farmers towards greater market participation and diversification to high-value crops. This change has helped increase farm earnings through higher price realization and reduction in wastages. Eventually, it is expected that mobile-based information services will influence the behavior pattern of farmers and this will facilitate adoption of improved techniques leading to better yields.

As an information platform to receive text messages – SMS or voice-message information –, mobiles provide the ability to get connected to new knowledge and information sources not previously available with the possibility of real-time, highly tailored information delivery. Even at this early stage, mobile phones are being used in Indian agriculture and are starting to deliver agricultural productivity improvements, an impact that is enhanced by the new mobile-enabled information services. The overall goal of using the mobile phone-enabled information delivery mechanism is to have inclusive growth by reducing the knowledge gap between large and small farmers and by creating awareness. The process of adoption of mobile telephony based information delivery systems has been slow and many of the models are still at an early stage of development. During the surveys although farmers indicated that they would like more information delivered to them via mobile, but they were not pro-actively seeking it out. Realising the full potential benefits of mobile phones is constrained by a set of factors that prevent farmers from fully leveraging the information they receive. The barriers apply more for the small farmers than large farmers; as large farmers are more able to leverage the benefits of the communication and information they can access. The constraints include shortcomings in physical infrastructure affecting access to markets, storage and irrigation. Issues regarding the availability of critical products and services including seeds, fertilisers, medicines and credit to small farmers also exist. As mobile penetration continues to increase among farming communities and information services continue to adapt and proliferate, scope exists for a much greater rural productivity impact in future. Issues of sustainability and widespread impact still

exist. Overtime, as more research is conducted in this area, we will be able to find answers to the questions regarding its usability, potential and sustainability.

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