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Role of Mobile Phone Technology in Improving Small Farm Productivity¹

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Abstract

Telecommunication, especially mobile phones have the potential to provide solution to the existing information asymmetry in various lagging sectors like agriculture. India's agricultural sector suffers from low growth rates and low productivity. Issues in access to information are weak points at every stage of the agri-supply chain. For small farmer-based economy like India, access to information can possibly enable better incomes and productivity to the farmers. This paper through focus group discussions and in-depth interviews with farmers, has tried to find answers to the use and impact of mobile phones and mobile-enabled services on agricultural productivity. The answers to these questions are of relevance to develop better policy environment conducive for small and medium farmers and have implications for mobile phone operators, information service providers, and policymakers. The study has shown that although, mobile phones can act as catalyst to improving farm productivity and rural incomes, the quality of information, timeliness of information and trustworthiness of information are the three important aspects that have to be delivered to the farmers to meet their needs and expectations. There exist critical binding constraints that restrict the ability of the farming community to realize full-potential gains and it is more so for small than large farmers.

Introduction

The next green revolution in India is to be preceded by the next generation of technology and infrastructural development. So far Indian agriculture is confronted with some major issues and challenges that continue to hinder the growth of this sector. The challenge for the government and policymakers is to 'regain agricultural dynamism'. The country needs a strong pull-up support to the agricultural sector which should grow at the rate of at least 4 per cent per annum, all the more so since in the past two years the growth in agriculture sector has been on an average 2 per cent only. Share of agriculture in country's GDP has also declined to about

17.1 per cent in 2008-09, which is almost half of that two decades ago. The agriculture sector in India still has about 52.1 per cent of the population dependent on it for livelihood. The infrastructure is crumbling in this sector and the investments as percentage of total investments have been as low as 7 per cent in 2006-07 (Economic Survey, 2008-09).

The major dilemma that agriculture sector faces under the situation of recent global food crisis and rising food prices is of striking a balance between the policies of food security and improving the income levels of farmers. Along with this, India's average operational landholding is less than 2 hectares, with a majority of the farmers being small or marginal landholders. Improving the livelihoods of small farmers has been a cornerstone of Indian government policy targets for many years and is imperative for the social and economic development.

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At the farmers' level, sustainability concerns are being expressed that the input levels have to be continuously increased to maintain yields at the old level. This poses a threat to the economic viability and sustainability of crop production. The states with positive and accelerating total factor productivity (TFP) growth in 1970s and 1980s, have started demonstrating stagnant or decelerating rate of growth in TFP since early-1990s (Kumar and Mittal, 2006). Research, extension, literacy and infrastructure have been identified as the most important sources of growth in farm productivity. Development of markets improves input-output market interface and it is of crucial importance for the growth in farm productivity. Human resource development is central to the adoption of technology and promotion of sustainable development. In agriculture, education creates conditions that enable farmers to acquire and use knowledge for decision-making regarding allocative and technical matters effectively (Mittal and Kumar, 2000; Kumar and Rosegrant, 1994; Evenson *et al.*, 1999; Fan *et al.*, 1999).

Information-based, decision-making agricultural system (Precision Agriculture) is designed to maximize agricultural production and is often described as the next great evolution in agriculture. The combination of Global Positioning System (GPS) and mobile mapping are supposed to provide farmers with the information for implementation of decision-based Precision Agriculture (Michael, 2008). In the context of India, use of mobile phones as a mode of providing agriculture-related information would depend on how far the mobile phone network has been able to link the farmers to market information — timely and accurately. The impact on productivity can be directly measured in terms of increased returns to the farmers with a trickle down effect on the cropping pattern and potential yield of the sowed crop. Information on the price factors — prices of inputs and output, and non-price factors like information about availability of inputs, quality of seeds, modern techniques, etc. would play the primary role in improving farm productivity.

The increasing penetration of mobile phone networks and handsets in India therefore presents an opportunity to make useful information available more widely. The key backdrop to this paper is a recent research, which has reported that introduction of mobile phones to Kerala fishermen could decrease price

dispersion and wastage by facilitating the spread of information which made the markets more efficient by decreasing risk and uncertainty (Jensen, 2007; Abraham, 2007). Mobile phones allow fishermen, particularly marginally more prosperous fishermen, to get timely price information which helps them to decide the best place to land and sell their daily catch. The recent introduction of a number of mobile-enabled information services suggests that it is timely to take a look at their impact on agriculture sector in India. These services deliver a wide range of information to the farmers. This paper is probably the first to look at the impact of mobile phones across Indian agriculture, particularly for small farmers. The objective of this study was to seek answers to such questions as: Are mobile phones in practice being used for agricultural purposes, and if so, how? Have mobile phones helped in driving improvement in agricultural productivity of farmers and if so, how? Which types of agricultural information are of high value for farmers? What are the constraints to the potential use of mobile phones in improving agricultural productivity? The answers to these questions have important implications for mobile phone operators, information service providers, and policymakers.

Hypothesis, Methodology and Data

The study has tried to test the hypothesis that mobile phones would help in reducing the informational asymmetry existing in the agricultural sector and would be helpful in improving farm productivity and profitability. There would be a positive impact on farmers' profitability by reduction in (i) transaction costs at both input and output levels; (ii) search costs through time saving; and (iii) travel cost. We expect the farmers' revenue to increase with increased information on prices through arbitrage and also through information on reduced wastage/spoilage, including that from crop infection. A better and timely decision-making on cropping pattern could also increase farm profits. The use of superior quality inputs, mainly seeds would also deliver better yields and profits. The crucial sense behind the study was that information received through mobile phones could play a complementary role to extension activities and would have a better impact than the other one-way information technologies.

The study is based on the information collected through focus groups and interviews carried out at the

Table 1. Mobile phone-based information services for farmers

Particulars	IFFCO – IKSL	Reuters – RML
Service started	June 2007	October 2007 (pilot in January 2007)
Locations of survey	Uttar Pradesh, Rajasthan	Maharashtra
Cost	Free voice messages Helpline service at a cost of Re 1/min	Rs 175 for three months Rs 350 for six months Rs 650 for one year
Nature of delivery	Voice message	SMS-text message for two crops subscribed by the farmer
No. of daily messages	5	4
Nature of information provided	Weather, Crop/animal husbandry advisory, Market prices, Fertilizer availability, Electricity timings, Government schemes	Weather, Crop-advisory (one crop), Market price (for 2 crops and 3 markets each), News (commodity-specific and general)
Other services offered	Customized advisory through helpline	None
Subscribers (at the time of investigation: August- October 2008)	Uttar Pradesh: 200,000 Rajasthan: 65,000	Maharashtra: 77,000 All India: 82,000

Comments If message is not immediately received by a farmer, it can be listened by dialling a number at a cost of Re1/ min. Messages are delivered at un-specified times of a day. Revenues are generated from the sale of SIM cards. Message can be retrieved if farmer's phone is on within 24 hours of message delivery. Messages delivered at pre-specified times of a day. Subscription is the only source of revenue.

village level and whole sale markets in some selected districts of the states of Uttar Pradesh, Rajasthan and Maharashtra (Annexure 1). The team conducted 15 focus groups (with 8-10 people in each group) and 40 individual interviews, of which 80 per cent were small farmers with less than 6 acres of land.² Being the first of its kind, the study didn't intend to cover all regions of India or to be fully representative of rural India, but focused deeply on the selected survey locations. The interviews covered such villages and farmers, which were using the standard mobile phone service as well as those which were linked to an agricultural information service. Interviewees were over the age of 18, mostly males and had varying degrees of formal education — some of the small farmers were graduates and a few were even post-graduates. These farmers cultivated a wide variety of crops, including staple and cash crops, and perishables and non-perishables. Almost

all of them were involved in multiple cropping and wheat was the most common crop grown amongst our interviewees.

A core part of the investigation was an assessment of new mobile phone-based information services targeting farmers. We sought to evaluate if these services were providing a more effective way of fulfilling farmers' information needs – timelier, more accessible, more consistent, and better customized – leading consequently to productivity gains. The mobile phone-based agri-information service providers evaluated were: IFFCO Kisan Sanchar Limited (IKSL)³ and Reuters Market Light (RML)⁴. Each of these sources disseminates information in different ways (Table 1).

There were a few underlying differences between these groups of farmers. Firstly, there was a difference

² This included the total land held by farming households. For this study, 6 acres was used as the cut-off, vis-à-vis Indian standards defining small farmers as having less than 5 acres of land.

³ IFFCO, a rural co-operative, runs a mobile-enabled farmers' information service in partnership with Bharti Airtel, called IKSL. It requires the farmers to purchase a special SIM card – IFFCO-Airtel Green Card through which they can receive free voice-mails containing agricultural information.

⁴ The global information services company operates an Indian-based mobile-enabled information business for farmers — RML. Through purchased subscription, farmers receive daily text messages on agricultural information.

in the information service accessed by these groups. The RML service was active in Maharashtra, while IKSL served Uttar Pradesh and Rajasthan. Secondly, the farmers interviewed in Maharashtra were significantly wealthier than their counterparts in Uttar Pradesh and Rajasthan and they reported substantially fewer challenges with infrastructural gaps, access to credit or other potential limitations on leveraging information. Finally, a significant proportion of the farmers interviewed in Maharashtra was involved in cultivating horticultural crops and the unique market characteristics of these crops might have played a role in the reported impacts.

Results — Impact of Mobiles Phones

In this section, results of the survey and focus group discussions have been presented. The section also presents how the interviewees perceived the gains from the use of mobile phones and mobile phone-enabled services.

ACCESS TO INFORMATION: A national survey of farmers by NSS has found that only 40 per cent of the farmers' households accessed⁵ information about modern agricultural techniques and inputs. The most popular information source of these households for accessing information was 'other progressive farmers', followed by 'input dealers' (Table 2). It emphasized the role of two-way communication vis-a vis one-way mode of information like radio, television and newspapers. Our survey also found that most farmers had access to a variety of agricultural information sources that were not mobile phone-based; however, the perceived quality and relevance of the information provided by these sources was highly variable. Most of the farmers we interviewed reported that they lacked access to a consistent and reliable information source and they had to often rely on a combination of traditional knowledge, experience and guesswork to make decisions, with the exception of villages having access to successful ITC rural kiosk programs.

RANGE OF INFORMATION REQUIREMENTS: The interviews and focus groups in different areas indicated that farm producers needed a wide range of information which

Table 2. Sources of agricultural information used by farmers

Source	Per cent of households
Other progressive farmers	16.7
Input dealers	13.1
Radio	13.0
Television	9.3
Newspaper	7.0
Extension worker	5.7

Source: Situation assessment survey of farmers conducted by the National Sample Survey Organization (June, 2005), GoI, New Delhi.

Note: The figures are proportions of the 40 per cent of households that reported accessing any information using each source.

varied through the growing season. The broad categories of information required were common to all of them, irrespective of their location and crops. These information categories were: *know-how* which provides a farmer with such fundamental information 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. It was found that small farmers prioritized information on weather, plant protection, seed variety and market prices as most important. In Uttar Pradesh and Rajasthan, close to 90 per cent of farmers reported information on seed as their highest priority, while over 70 per cent cited market prices as the most important category. Although farmers were also interested in other categories of information, like best cultivation practices, crop choice, etc., only a small sample prioritized them.

VARIATIONS BETWEEN SERVICE PROVIDERS: In our sample of farmers, 41 per cent of the farmers were subscribers to either of the two information services and no farmer in the sample subscribed to any other similar service.⁶ All IKSL subscribers in a state received the same voice messages, irrespective of location or crop choice. By contrast, RML allowed the farmers to choose two crops and customized information for each farmer. RML also supplied weather information at the *taluka* level. IKSL's

⁵ Survey evaluated actual access as opposed to ability to access

⁶ The only other relevant service encountered in the areas surveyed was the BSNL helpline. It was a toll-free service that farmers could call for agricultural information. However, in every single case where a farmer we interviewed was aware of this service, it was described as "not satisfactory" and there were no examples cited of successful use of this service.

voice messages were sent at un-specified timings during a day and required the farmer to access them at the moment they were received. RML delivered information through text message at preset times during the day, enabling a more convenient access for the farmer at a time of his choice⁷. However, an important factor in the choice of information delivery method was literacy. Most IKSL farmers reported that the voice message was preferable to a text message for this reason. RML subscribers largely preferred text message and did not report literacy concerns⁸. Overall, a significant difference was found in subscribers' perception about these two information services. The RML service was reported to deliver a better-tailored information to the subscribers as well as had greater ease of access. The IKSL service was generally found to be more hit or miss in the value it delivered and was often described as lacking in relevance to farmers' needs.

AGRICULTURAL PRODUCTIVITY: The study indicated that mobile phones have started making impact on the agricultural productivity, but it is still a long way to go. While most farmers reported that their mobile phones were primarily used for social purposes, almost all interviewees were using their mobile phones for at least some agricultural activity, with some respondents citing significant productivity gains. Table 3 ranks the type of information accessed by the interviewees on their mobile phones and compares it with the information accessed from other sources, as reported in the NSS 59th round survey. Information regarding seeds was the most frequently accessed information in our sample. It was true in the NSS survey as well. Mandi (market) price was the second most important piece of information accessed by the farmers in our sample, followed by plant protection and fertilizer application. While the rankings differed somewhat, information on fertilizer application and plant protection was also

Table 3. Ranking of the use of modern technology by farmers to access agricultural information

Information	Use of modern technology ¹	Use of mobile phone ²
Seed	I	I
Mandi (output) price	NA	II
Fertilizer application	II	IV
Plant protection	III	III
Harvesting and marketing	IV	V
Farm machinery	V	VI

Notes: ¹Results are based on the information provided in the *Situation Assessment Survey of Farmers, Access to Modern Technology for Farming*, NSS 59th Round, NSSO, GoI. June 2005. The sources of information used in this table are radio, television, newspapers, input dealers and other progressive farmers.

²Information is based on the survey done under the study, consisting of individual farmers in Uttar Pradesh, Rajasthan and Maharashtra.

NA: NSS survey did not cover 'Mandi Prices'.

crucial in the NSS list. Although our sample was small, the nature and frequency of information accessed on the mobile phone depicted a close resemblance with the nature and frequency of information accessed by the farming households in the NSS. Traders and commission agents comprised a segment that was making daily use of their mobile phones and offered some evidence that their mobile phone-use was improving the overall market efficiency.

Almost all small farmers reported some increase in convenience and cost savings by using their mobile phones as basic communication devices to seek information like input availability or market prices. Beyond basic communications, however, the team found differences in mobile phone usage and benefits gained by the farmers across different states.⁹ Overall,

⁷ RML had started their service with voice messages, but later switched to text messages as they found that voice delivery limited the content that could be delivered and prevented predictable message delivery. The switching enabled greater accessibility (predictable time delivery, text message permanently stored on phone) and content customization.

⁸ Maharashtra has a higher literacy rate than the other regions surveyed. Literacy levels by state were: Maharashtra (76.9 per cent), Rajasthan (60.4 per cent), and Uttar Pradesh (56.3 per cent). Source: *Census of India* (2001).

⁹ Positive impacts were specifically reported in only 1 of the 6 focus groups involving IKSL subscribers. By contrast, all focus groups involving RML subscribers in Maharashtra reported positive impacts from the use of service. Out of 44 interviewed small farmers who were IKSL subscribers, eleven reported positive impacts from the use of service. It may be noted that 10 of these 11 were from individual interviews and were specifically sought out by the team to recount examples of impact.

the Maharashtra farmers reported greater use of their mobile phones to access information as well as greater use of the mobile-enabled information services. These farmers also reported a diverse set of benefits accruing from mobile phone usage, including yield improvements, price improvements and increasing revenues from better adjusting supply to market demand.¹⁰ By contrast, among the farmers in Uttar Pradesh and Rajasthan who reported some benefits from mobile phone access, almost all opined that these were limited to benefits from improvements in yield only. However, some individual farmers did report about the benefits in getting higher prices by arbitrage in Uttar Pradesh.

Drivers of Mobile Phone Impacting Farm Productivity

With all interviewees reporting that mobile phone had generated positive economic benefits, the nature of that impact can be categorized in three ways: (i) easy access to customized content, (ii) mobility, and (iii) time-saving or convenience. The second category is unique to the use of mobile phones. The others reflect the fact that mobile phone has become the primary (or only) communication mode for many farmers. However, as we note later, the beneficial impacts of mobile phone on farm productivity depend also on other basic infrastructure.

Farmers described ‘easily accessible’ and ‘customized content’ as the key advantages of the mobile phone-enabled information services. A number of IKSL and RML subscribers reported that they had successfully averted potential losses by reacting quickly to information about weather and crop disease. Others reported improved yields by adopting new seed varieties and cultivation practices. Farmers who acted on cultivation information reported that they were benefited by replacing traditional “common sense”

practices with modern cultivation techniques. Weather information helped prevent seed and crop losses, and farmers in Maharashtra utilized weather information to adjust irrigation levels.¹¹ We found that in the case of the RML, which provides highly customized information on weather and market prices, all of the interviewed subscribers reported positive benefits from the information accessed through the service. Amongst them, a few farmers could even quantify these benefits precisely and these benefits were in the range of 5-25 per cent of earnings, with larger gains typically attributable to the adoption of better planting techniques. Several farmers in Maharashtra, who had only recently adapted to the changes as a result of information received, expected the benefits to become visible in the coming harvesting season.

Mobile phones confer distinct advantages as a communication link in isolated circumstances because of its distinct feature of *mobility*. Mobile phones serve as a two-way communication mode and provide access to the information service even in the fields. This included the ability to describe plant diseases from the field to the experts and to coordinate better with the hired labour. Traders and commission agents reported improvements from their ability to deal with truck breakdowns and also the ability to shift crops once en route in response to the changing market conditions.¹²

Almost all the interviewed farmers reported some benefits in terms of *greater convenience such as time saving* from using mobile phone as a basic mode of communication. For some of these farmers, a mobile phone represented the only convenient access to communication. This is not surprising, as fixed line communication in the rural India remains extremely poor¹³. For many of the small farmers in our survey, the savings stemmed typically from avoiding local travel, whose cost could range from Rs 100 to Rs 200 per

¹⁰ Farmers reported using market demand predications to adjust the quantity of supply they harvested and took to market during a specific period. Future market demand predications were included, where possible, in the news message sent to RML subscribers in the afternoon.

¹¹ By reducing the amount of irrigation when rain was forecast, farmers could reduce the chances of fungal disease as well as conserved water.

¹² Although this investigation was not able to directly study the impact of mobile phone on improving the overall efficiency of markets, these activities presumably contribute to smoothing out demand/supply imbalances and reducing overall wastage.

¹³ Uttar Pradesh tele-density is the lowest among the regions surveyed with 1.4 fixed telephone lines per 100 people and 3.7 mobile lines per 100 people. In Maharashtra, these figures are 5.8 and 27.3, respectively as per Telecom Regulatory Authority of India (TRAI) for March 2008. Rajasthan also had 2.7 land lines and 21 mobile lines per 100 people.

trip. A few farmers reported to have derived greater benefits from the ability to make better decisions about the place for selling their output after getting information about market prices for several local and distant markets. In the villages with a successful ITC rural kiosk program, access to mobile phones increased the range of service of the local representative — the Sanchalak. The use of mobile phone also delivered convenience benefits to farmers who were starting to substitute some physical meetings with mobile phone conversations.¹⁴ It was also noted that mobile phone was essential when the village suffered power shortages and the rural kiosk was not available.

Constraints

Although it was evidenced that mobile phones were being used in ways which contributed to farm productivity, to leverage the full potential of greater access to information enabled by a mobile phone, particularly for small producers, will require significant improvements in the supporting infrastructure and also in capacity-building amongst farmers to enable them to use the information they access more effectively.

INFRASTRUCTURAL CONSTRAINTS: All seven of the focus groups involving predominantly small farmers in Uttar Pradesh and Rajasthan, highlighted infrastructural gaps that affected their ability to realize farm productivity gains. The four specific infrastructural constraints reported were: (i) insufficient availability of critical resources (reduces yield); (ii) inadequate irrigation (reduces yield); (iii) poor physical access to markets (reduces realized prices); and (iv) inadequate crop storage (reduces realized prices). Six of the seven focus groups highlighted problems such as difficulties in

sourcing critical resources like fertilizer, seed and medicine. There were also concerns about the difficulties in identifying bona fide products as many counterfeits were being sold in the local markets. In several groups, the farmers desired to have information which would help them in identifying counterfeit products, which remain a significant productivity drain in India¹⁵. Three of the focus groups specifically mentioned lack of irrigation as a significant constraint and two of them noted that it had affected the sustainability of cultivating desired crops¹⁶. Poor road infrastructure and lack of refrigerated transport were also reported as problems by the farmers affecting their access to markets. Many small farmers used small carts powered by animal or small engines to transport their goods to the market and reported that transport costs represented a prohibitive barrier to accessing markets. This limited their opportunity to profit from market price differences by selling at markets where higher prices were available. Lack of storage facilities was curtailing farmers' ability to choose when to sell their crop and thereby was limiting options to maximize profits. One group of farmers noted that lack of storage was a contributing factor to the effective monopoly of the local commission agents and it caused them to receive lower prices for their produce.

As a counterpoint to the findings in Uttar Pradesh and Rajasthan, the farmers in Maharashtra did not report infrastructural constraints outside of a limited mention of cold storage concerns.¹⁷ There was widespread irrigation and diversification into water-dependent, high-value crops like horticulture.¹⁸ There were no perceived concerns with the availability of inputs¹⁹ or access to markets. Not surprisingly, these farmers consequently

¹⁴ In one ITC village, it was reported that 20 per cent of the farmer clients used their mobile phones to communicate with the Sanchalak. However, even these farmers continued to travel to the Sanchalak's home for in-person meetings.

¹⁵ Input constraints related not only to availability in general, but also to the availability of "genuine" inputs.

¹⁶ Although only specifically mentioned by three focus groups, the team found that irrigation was not available to smaller farmers in almost all of the regions surveyed in Allahabad, Agra and Rajasthan. The primary reason cited was electricity problems that made the tube-wells ineffective. Unlike Maharashtra, which suffered from electricity limitations but had predictable electricity timings, the electricity timings in the poorer regions were typically reported as unpredictable. Also unlike Uttar Pradesh and Rajasthan, the surveyed areas in Maharashtra had strong canal/river irrigation system.

¹⁷ Two focus groups reported access to storage facilities, while two groups had no access, particularly to cold storage. However, even in the latter case, the lack of access to cold storage did not prevent them from taking advantage of market arbitrage opportunities.

¹⁸ The availability of electricity (essential for some tube-wells) ran on a predictable schedule. Consequently, it was not described as a problem by the farmers surveyed despite daily limitations of availability. Electricity was available from 5 hours/day to 12 hours/day.

¹⁹ While one focus group desired to get information on seed availability, it appeared to be more in order to save search costs rather than difficulty in ultimately getting the product. The greatest challenge noted by focus groups was primarily around price volatility.

reported greater ability to achieve both yield and price benefits from leveraging information.

CREDIT CONSTRAINT: The lack of formal credit can prevent purchasing of important inputs and can also reduce the farmer's chances of getting the best price because of choice restrictions (explicit or implicit) on where he can sell his crop.²⁰ Poor farmers lacking in collateral and credit history find it difficult to obtain loans from the formal financial institutions, and many of them have to depend on informal channels such as moneylenders or agricultural traders. This often results in farmers paying exorbitant interest rates and facing restrictions on where they can sell their crop. Access to credit was a problem raised by the majority of small farmer focus groups, although we were unable to evaluate reliably what difference this hurdle made in the price received by them. The middlemen dominate the supply chains and are the major price setters in the system. Small farmers are often unaware of how prices are set and end up taking whatever price they are offered. Even if the market price information is available to them, they are often unable to exploit the price disparities that exist between major and minor markets due to their inability to transport their produce. We recorded many contradictory responses as to whether or not farmers were bonded and thus had to sell to a specific trader, commission agent or moneylender who had extended them credit earlier in the year.

CAPACITY FOR RISK-TAKING: For information to drive agricultural productivity, farmers must be willing to try new strategies which may include new farming techniques. While we found a small number who had made changes based on the information they received via their mobile phones, there were some who expressed reluctance to try new approaches even when they had access to relevant information. ITC staff informed that as per their experience, persuasion of small farmers to adopt new seed varieties or farming methods often requires a combination of approaches: repeated dissemination of information, demonstration plots and dialogues with farmer. Several focus groups in villages where hybrid seed had been introduced noted that the seed companies also promoted diffusion of the seeds through demonstration plots and capacity building measures. Therefore, it seems likely that for broader rural productivity gains a set of similar capacity-building

activities to complement the basic information provision will be required.

Conclusions

This study has provided a first look at the potential of mobile phones in affecting the agricultural sector as a whole. The study has reported many examples of the benefits created by the characteristics of mobility, customized content delivery and convenience of mobile phones. As mobile phone penetration continues to increase among the farming community and information services continue to adapt and proliferate, sufficient potential exists for a much deeper rural productivity impact in future, but achieving full productivity potential will depend on reducing other constraints which limit the use of information that farmers can obtain through their mobile phones.

One key element is that the service providers have to leverage the benefits of mobile phone such as portability, flexible content delivery capability and two-way communication to deliver low-cost but highly customized solutions. Farmers must be able to get information delivered to them at a time and place of their choosing. Even at this early stage of mobile phone revolution in Indian agriculture, the study has reported the signs of agricultural productivity improvements, an impact which is enhanced by the new mobile phone-enabled information services. The most common benefit of mobile phone has been found as a basic device of communication because for many of the farmers, it was the only convenient access to information.

Realization of full potential impact of mobile phones is constrained by shortcomings in physical infrastructure affecting access to markets, storage and irrigation. Issues also arise with the availability of inputs and credit. Equally, to make full use of delivered information, farmers must have sufficient risk-taking capacity and willingness to experiment with new strategies and techniques disseminated. Social networks like ITC may play an important role in building trust and confidence required to influence the adoption of new mindsets and actions by small farmers.

Increased public and private investments will be necessary to bridge the critical infrastructural gaps. Policy changes may also be needed to encourage better access to high-quality inputs and credit for small

²⁰ This is sometimes referred to as the problem of "bondedness".

farmers. Increased extension services and capacity-building efforts can complement information dissemination via mobile phones and associated services to accelerate the adoption of new techniques. However, even in the case of poor farmers facing significant constraints, it has been found that there are opportunities to realize productivity gains from the adoption of new farming practices and actions to mitigate crop losses.

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Annexure 1

Survey locations

State	District	Village
Uttar Pradesh	Allahabad	Saidabad, Bijhayan, Malak Harhar, Vardaha, Panwar
	Agra	Medhapur, Mania
	Mathura	Usfar, Lalpur
Rajasthan	Alwar	Khairtal
	Dausa	Khanvaas
	Bhilwara	Lesua
	Baran	Himoniya
	Jaipur	Murali Papmaanbali
Maharashtra	Satara	Arphal, Bharatgaon, Indoli
	Pune	Kumbhar