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Impact On Small Farmers and Fishermen Through Use Of Mobiles in India[1]

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Abstract

Telecommunication and more specially 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 is a week point at every stage of the agri-supply chain. For small farmers base economy like India, access to information can possible enable better incomes and productivity to the farmers. This paper through focus group discussions and in-depth interview with farmers in villages of India, has tried to find answers to the use and impact of mobile and mobile enabled services on agricultural productivity. The answers to these questions are of relevance to develop better policy environment conducive for the small and medium farmers and has implications for mobile operators, for information service providers, and for policy-makers. The results show that although, mobiles can act as catalyst to improving productivity and rural incomes, the quality of the information, the timeliness of the information and trustworthiness of the information are the three important aspects that has to be delivered to the farmers, to meet there needs and expectations. There exist critical binding constraints that restricts the ability of the farming community to realise gains at full potential and this is more for the small than to large farmers

Keywords: Mobile and Agriculture, India, Productivity

JEL codes : Q13, Q16, Q18

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Surabhi Mittal, Sanjay Gandhi and Gaurav Tripathi

1. INTRODUCTION

The next generation green revolution in India is to be preceded by the next generation of technology and infrastructure development. So far Indian agriculture is confronted with some major issues and challenges, that continue to hinder the growth in this sector. The challenge for the government and policy makers is to 'regain the agricultural dynamism'. The country needs a strong pull-up support to agriculture sector which should grow at least at the rate of 4 per cent per annum, all the more since in last two years the growth in agriculture sector was only 2.5%. Share of agriculture in country's GDP has also declined to about 18% in 2008 which is almost half of that two decades ago. Agriculture sector in India still has more than 58 percent of the population dependent on it for livelihood. The infrastructure is crumbling in this sector and the investments have stagnated.

The major dilemma that this sector faces in the present situation of recent global food crisis and rising prices is to meet a balance between the policies of food security and improving the income levels of the farmers. Along with this India's average operational land holding is less than 2 hectares, and the new farming models like contract farming are highly successful in mobilising small farmers to divert to commercial production, mainly of high value commodities. There are an estimated 127.3 million 'cultivators' in India. The majority of them are farmers subsisting on small plots of land less than 5 acres[2] in size (2001, Indian census). Improving the livelihoods of small farmers has been a cornerstone of Indian government policy targets for many years and is imperative for social and economic development.

At the farmers' level, sustainability concerns are being expressed that the input levels have to be continuously increased in order to maintain the yield at the old level. This poses a threat to the economic viability and sustainability of crop production. The states with positive and accelerating TFP growth in 1970's and 1980's have started demonstrating stagnant or decelerating rate of growth in TFP since early 1990's (Kumar and Mittal, 2006). Research, extension, literacy and infrastructure have been identified as the most important sources of growth in productivity. Development of markets improves input-output market interface and it is of crucial importance for growth in productivity. Human resource development is central to 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 maximise agricultural production and is often described as the next great evolution in agriculture. The combination of GPS and mobile mapping are supposed to

[2] India's average operational land holding is less than 2 hectares (4.94 acres).

provide the farmers with the information for implementation of decision-based Precision Agriculture (Michael, 2008). In context of India, mobiles as a mode of providing agriculture related information would depend on the how the mobile network has been able to link the farmers to the 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 prices and non- price factors like information of availability of input, quality of seeds, modern techniques would play the primary role in improving productivity.

The increasing penetration of mobile networks and handsets in India therefore presents an opportunity to make useful information more widely available. The key backdrop to this paper is a recent research, which found that introduction of mobile phones to Kerala fishermen decreased price dispersion and wastage by facilitating the spread of information which made the markets more efficient of markets by decreasing risk and uncertainty (Jensen, 2007, Abraham, 2007). Mobiles allow fishermen, particularly marginally more prosperous fishermen, to get timely price information and decide the best place to land and sell their daily catch. The recent introduction of a number of mobile-enabled information services suggests it is timely to take a fresh look at their impact on agriculture in India. These services deliver a wide range of information to farmers and fishermen. This paper is the first to look at the impact mobile phones across Indian agriculture, particularly for small farmers. The objective of this study was to sought answers to: Are mobile phones in practice being used much for agricultural purposes, and if so how? Have mobile phones helped drive agricultural productivity improvements for farmers and fishermen, and if so how? Which types of agricultural information have the most value for farmers and fishermen? What constraints are there on the potential for mobile phones to improve agricultural productivity? The answers to these questions have important implications for mobile operators, for information service providers, and for policy-makers.

2. METHODOLOGY

The results are based on information collected through focus groups and interviews carried out at village level and whole sale markets in some selected districts of Uttar Pradesh, Rajasthan, Tamil Nadu, New Delhi and Maharashtra (Fig 1, table 1). These visits comprised a series of focus group and individual interviews with farmers, fishermen, labourers, traders, commission agents, non-profit organizations and businesses involved in the agriculture sector. The team conducted 17 focus groups and 46 individual interviews. In total over 200 people were interviewed, of whom 160 were small farmers with less than 6 acres of land.[3] The aim of the fieldwork was to look at the ways in which mobile can affect agricultural productivity, with a focus on smaller farmers. It was not intended to cover all regions of India or to be fully representative of rural Indian villages. The interviews covered villages and farmers using the standard mobile phone service as well as those with an agricultural information service was available. With the exception

[3] This included total land held by farming households. For the purpose of the study 6 acres is used as the cut-off , vis-à-vis Indian standards definition of small farmers as less than 5 acres of land.

of the investigation to Delhi's main fruit and vegetable market, the *Azadpur mandi*, all of the locations covered were rural, with village populations ranging from 3,000 to 10,000. Interviewees were over the age of 18, mostly male and had varying degrees of formal education. A few of the small farmers had obtained university degrees, some of them were even post-graduate degrees. The farmers interviewed grew a wide variety of crops including staple and cash crops, perishables and non-perishables, and crops grown for household consumption. Almost all were involved in growing multiple crops, as is normal, and wheat was the most common crop grown amongst our interviewees.

Figure 1: Interview and research locations

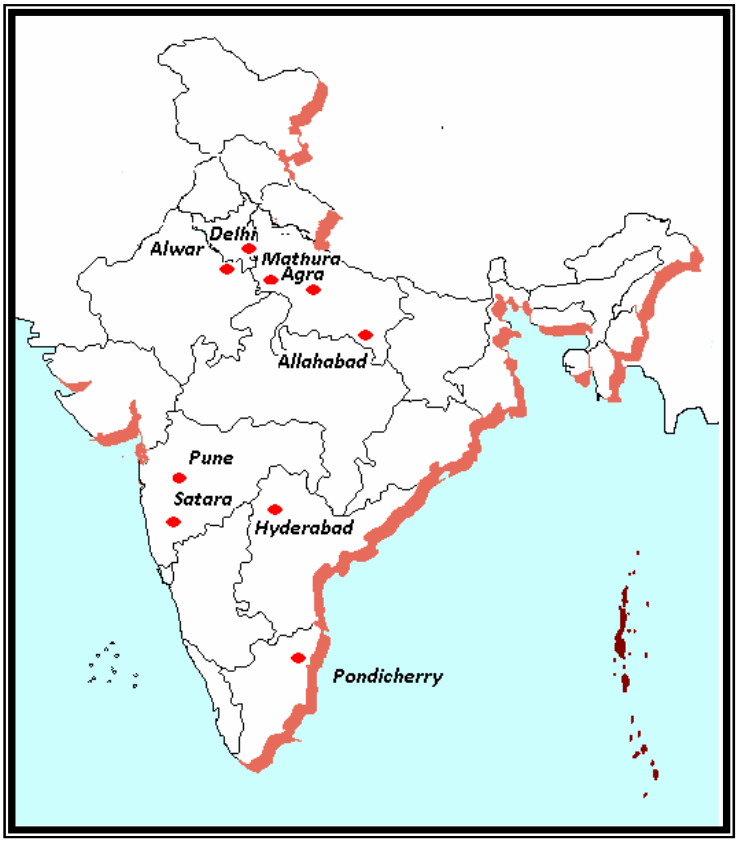

Table 1: Basic facts about regions covered

Region	Population	Percent Urban	Per Capita GDP (Rs.)	Fixed Lines per 100 people	Mobile Lines per 100 people
Maharashtra	104.2	42.4	41,514	5.8	27.3
New Delhi – NCR	15.9	93.2	66,431	14.4	96.9
Rajasthan	61.8	23.4	20,095	2.7	21.0
Tamil Nadu	64.9	44.0	34,424	5.8	12.8
Uttar Pradesh	181.9	20.8	15,383	1.4	3.7

India	1,106.0	27.8	29,617	3.4	22.8

Sources:
1. Population, Per capita GDP (current and constant prices) Central Statistical Organization, Ministry of Statistics and Programme Implementation, GoI. Population and per capita GDP are for 2005-06.
2. Percent Urban is based on Census of India 2001 data
3. Mobile and Fixed Line data: Telecom Regulatory Authority of India (TRAI) for March 2008.

A core part of our investigation was an assessment of new mobile-based information services targeting farmers and fishermen. We sought to evaluate whether these services were providing a more effective way of fulfilling farmers' information needs – more timely, more accessible, more consistent, better customized – consequently leading to productivity gains. The mobile based agri-information service providers evaluated were - IFFCO Kisan Sanchar Limited (IKSL), Reuters Market Light (RML) and the Fisher friend program for fishermen[4]. Each of these sources and distributes information in different ways. The details are presented in table 2.

Table 2: Mobile information services for farmers

	IFFCO – IKSL	**Reuters – RML**
Began Service	June 2007	October 2007 (pilot in January 2007)
Locations of Survey	Uttar Pradesh, Rajasthan, Tamil Nadu	Maharashtra
Cost	Free Voice messages Helpline service at a cost of Rs. 1/min	Rs. 175 for three months Rs. 350 for six months Rs. 650 for an year
Nature of Delivery	Voice message	SMS-text message for two crops subscribed by the farmer
# of Daily Messages	5	4
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	• Customized advisory through helpline	• None
Subscribers (at time of investigation)	• Uttar Pradesh: 200,000 • Rajasthan: 65,000	• 82,000 (India-wide); 77,000 in Maharashtra
Comments	• If message not immediately received by farmer it can listened to by dialing a number at a cost of Rs1/	• Message will be retrieved/saved if farmer's phone is on within 24 hours of message delivery • Messages delivered at preset

[4] The details of these organisations is given in Annexure 1.

	min. • Messages delivered at unpredictable times of day • Revenues are made from the sale of SIM cards	times of day • Subscription is only revenue source

In our sample of farmers, 41% of those interviewed were subscribers to one of the two services and no farmer in the sample subscribed to any other similar service.[5] All IKSL subscribers in the state received the same voice messages irrespective of location or crop choice. By contrast, RML allowed farmers to choose two crops and customized the information each farmer received. RML also supplied weather information at the *taluka* level– approximately a 50 km radius[6]. IKSL's voice messages were sent at unpredictable times during the day and required that the farmer access them at the moment they were received. RML delivered information via text message at preset times during the day, enabling more convenient access to the farmer at a time of his choosing[7]. However, an important factor in choice of delivery method is 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 concerns[8]. Overall, we found a significant difference in subscribers' perception of these two information services. The RML service was reported as having information better tailored to the subscriber as well as 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.

Fisher friend builds upon an existing service that provides information to fishermen through physical centers in fishing villages. The Fisher friend program relays the same information by mobile in order to solve the "last mile" problem for fishermen at sea. Perceptions of the information service were overall mixed. This partly reflected technical challenges faced by the program that affected accessibility and the updating of information[9]. While fishermen reported varying levels of satisfaction with the different information categories provided, almost all fishermen interviewed who were able to access the service found value in the weather information provided and having mobile access at sea.

Table 3: Mobile information service for fishermen

[5] The only other relevant service encountered in the areas surveyed was the BSNL helpline. This 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.

[6] Taluka is an administrative division of a larger district within a state.

[7] RML had started their service with voice messages, but later switched to text messages as they found that voice delivery limited content that could be delivered and prevented predictable message delivery. The switch 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: Maharashtra (76.9%), Rajasthan (60.4%), Uttar Pradesh (56.3%). Source: Census of India 2001.

[9] The information provided was sourced centrally and distributed through MSSRF's local village centres as well as through Fisher friend. Fishermen reported that for significant periods of time the entire service or certain information – such as optimal fishing zone - was not available.

	FISHER FRIEND
Launch date	December 2007 (pilot – still in pilot phase)
Cost	Free (handsets and service)
Nature of Delivery	Menu-based access (text)
Information Provided	• Weather (wave height, wind speed) • Market Prices • Optimal Fishing Zone (longitude and latitude) • Rural Yellow Pages • Government Schemes
Comments	• Estimated range of service at sea is 5 nautical miles • Availability of information has been sporadic – at time of investigation service had not been functioning every day

3. INFORMATION NEEDS OF FARMERS

The Indian agricultural sectors productivity growth has been hampered by major challenges including deficits in physical infrastructure, in the availability of agricultural inputs such as seed, fertilizer and services in rural areas, and in access to information. The weaknesses in the physical infrastructure include poor road and other transportation infrastructure, inadequate irrigation facilities, limited storage facilities, limited irrigation and inadequate wholesale marketplaces- lack of packing, grading and sorting infrastructure. 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[10]. 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..

Small farmers often struggle to access high-quality inputs such as advanced seed varieties, or services such as soil testing or credit. The lack of efficient distribution networks and easy road access means rural markets are typically fragmented and geographically isolated.. There are therefore significant hurdles to organizations seeking to supply these markets cost-effectively. The lack of availability of critical resources such as fertilizer has also given rise to concerns about the distribution and sale of counterfeit products.[11] Poor farmers lacking in collateral and credit history find it difficult to obtain loans from formal financial institutions, and many of them depend on informal

[10] Some initiatives to improve the efficiency and transparency of individual wholesale markets are taking place. They seek to increase transparency and overall market efficiency by improving backward linkages to farmers and forward linkages with wholesale purchasers. One example of this is the SAFAL terminal market in Bangalore.

[11] An article citing recent estimates by the Agrochemicals Policy Group reported that spurious and substandard pesticides worth Rs. 1,200 crores are sold to farmers every year in India resulting in loss of crops worth Rs. 6000 crores (1 crore = 10 million rupees). See: http://businessstandard.co.in/india/storypage.php?autono=33441.

channels such as moneylenders or agricultural traders.[12] This often results in farmers paying exorbitant interest rates and facing restrictions on where they can sell their crop.

Finally, there is very uneven access to information. A national survey of farmers found that only 40% of farmer households accessed (survey evaluated actual access as opposed to ability to access) information about modern agricultural techniques and inputs.[13] The most common information source used by households accessing information was "other progressive farmers" followed by input dealers. (Table 4). The relevance of the information available is another issue. For example, farmers need accurate weather forecasts but even when they are able to get weather forecasts, they often have to make do with state level forecasts which are too general to allow for effective planning and action.

Table 4 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
Note: The figures are proportions of the 40% of households that reported accessing any information using each source.

The interviews and focus groups in the different areas indicated that producers need a wide range of information which vary through the growing season. Nevertheless, the broad categories of information required were common to all of them, irrespective of their location and crops. These categories were: *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. These are set out in Table 5.

Table 5: Farmers' Information Needs

Category	Examples	Typical Information Needs
Know-how	• Crop choice • Seed variety	• What are options for new crops or seed varieties?

[12] The share of rural credit from non-institutional agencies is above 40%.
[13] *Situation assessment survey of farmers conducted by the National Sample Survey organization (June, 2005), GoI* . The survey evaluated access to information on "Modern Technology for Farming". Examples of the information categories assessed include: improved seed variety, fertilizer application and plant protection.

		• Are there higher value crops or better seed varieties I could be planting?
Context	• Weather • Plant protection • Cultivation best practice	• When should I sow? When should I harvest? given my climate/soil • What are cultivation best practices for my crops and soil? • What inputs should I use? How to best apply them? Where can I find them?
Market Information	• Market Prices • Market Demand • Logistics	• What are prices and demand in relevant markets? • Has there been a transport breakdown?

Of this range of information requirements, it was found that small farmers prioritized weather, plant protection (disease/pest remediation), seed information and market prices as the most important. In Uttar Pradesh and Rajasthan, close to 90% of farmers reported seed information as the highest priority while over 70% cited market prices as the most important category[14]. While farmers were interested in the other categories of information, such as cultivation best practices and crop choice, only a minority of the sample prioritized them. Typically these other categories would be most significant where the farmer was seeking to try new strategies in order to increase yields and revenues, although almost all farmers will need to introduce crop changes periodically.

We found that most farmers had access to a variety of non-mobile enabled information sources that they consulted for agricultural information. This included TV, radio, newspapers, other farmers, government agricultural extension services, traders, input dealers, seed companies and relatives. However, the perceived quality and relevance of the information provided by these sources was highly variable.. Most of the farmers we interviewed lacked access to consistent, reliable information for many of their needs and often relied on a combination of traditional knowledge, experience and guesswork to make decisions. With the exception of villages with access to successful ITC rural kiosk programs, most of the farmers surveyed did not have a single channel or access platform that served as a comprehensive source for their information needs.

4. IMPACTS OF MOBILE

The following sections turn to the findings from the fieldwork. We report how our interviewees perceived the specific mobile-based services before going on to consider the productivity impacts of mobile which emerged from the research.

4.1 Agricultural Productivity

Overall, the research indicated that mobile phones are starting to have an impact on agricultural productivity, but its still a long way to go. While most farmers reported that their mobile phones were primarily used for social purposes, almost all interviewees were

[14] Percentages refer to results from 22 individual interviews conducted in Uttar Pradesh and Rajasthan.

using their mobiles for at least some agricultural activity, with some respondents citing significant productivity gains. Annexure 2 ranks the 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[15]. Information regarding seeds is the most frequently accessed information in our sample. This is true of the NSS survey as well. Mandi (market) price is the second most important piece of information accessed by farmers in our sample, followed by plant protection and fertilizer application. While the rankings differs somewhat, information on fertilizer application and plant protection are also crucial in the NSS list. Although our sample is small, the nature and frequency of information accessed on the mobile bears close resemblance with the nature and frequency of information accessed by farming households in the NSS. Traders and commission agents comprised a segment making daily use of their mobile phones and offered some evidence that their mobile use was improving overall market efficiency. We also found that a number of fishermen were deriving safety as well as economic benefits (decreased potential losses, increased catch) from the ability to communicate and access information while at sea.

Among small farmers, almost all reported some increase in convenience and cost savings from using their mobile phones as basic communications devices to seek information such as input availability or to check market prices. Beyond basic communications however, the team found differences between reported mobile usage and benefits gained between the farmers surveyed in Uttar Pradesh and Rajasthan as opposed to the farmers surveyed in Maharashtra.[16] Overall, the Maharashtra farmers reported greater use of their mobile phones to access information and also greater use of the mobile-enabled information services. These farmers also reported a diverse set of benefits accruing from mobile usage including yield improvements, price improvements and increasing revenues from better adjusting supply to market demand. [17] By contrast, among the farmers in Uttar Pradesh and Rajasthan who reported some benefits from mobile access, almost all said these were limited to benefits from improvements to yield alone.

There were a few underlying difference between these groups of farmers. First, there was a difference 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 Uttar Pradesh and Rajasthan's counterparts and reported substantially fewer challenges with infrastructure gaps, access to credit or other potential limitations on leveraging information. Finally, a significant proportion of farmers interviewed in Maharashtra

[15] . Results 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.

[16] 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 use of the service. Overall, of small farmers interviewed who were IKSL subscribers, eleven out of 44 reported positive impacts from use of the service. It should be noted that 10 of these 11 were from individual interviews and were specifically sought out by the team to recount examples of impact.

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

were involved in cultivating horticulture and the unique market characteristics of this crop may have played a role in the reported impacts.

4.2 Drivers of mobile impacts on productivity

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

4.2.1 Easily accessible and customized content

Farmers described this as a key advantage of the mobile-enabled information services. A number of IKSL and Reuters' subscribers reported that they had successfully averted potential losses by reacting quickly to weather and disease information. Others reported improved yields by adopting new seed varieties and cultivation practices. Farmers who acted on cultivation information reported that they benefited from replacing traditional "common sense" practices with modern cultivation techniques. Weather information helped prevent seed and crop loss, and farmers in Maharashtra relied on weather information to adjust irrigation levels.[18] We found that in the case of the RML, which provides highly customized information on weather and market prices, all of the subscribers interviewed reported positive benefits from information accessed through the service. By contrast, the findings were overall more mixed from those with the IKSL service, which provides the same information to all subscribers in a given state. Of all farmers who reported economic benefits from using one of the information services, four farmers were able to quantify these precisely. The size of the benefit they reported ranged from 5-25% of earnings, with the larger gains typically attributable to the adoption of better planting techniques. Several farmers, particularly in Maharashtra, reported that they had only recently made changes as a result of information received and that they expected to realize benefits in the coming season.

Fishermen reported several benefits of information received through the Fisher friend program, both while on shore and at sea. Weather information helped increase revenues by influencing some fishermen to venture out to sea in cases where traditional judgment kept most fishermen on shore. [19] The revenue impact was multiplied when those at sea communicated the situation to the others who had stayed on land, thus persuading them to go fishing on that day as well. Fishermen also reported benefits from their use of fishing zone information. This information provides specific coordinates (longitude and

[18] By reducing the amount of irrigation used when rain is forecast farmers reduce the chances of fungal disease as well as conserving water.

[19] An example was given that during a recent 3-week stretch the fishermen would have gone out to sea only 3 times if relying on traditional habits and judgment. However, armed with knowledge of wave height, wind speed and other weather conditions they ventured out 10 times instead and managed to earn incremental revenues.

latitude) that point fishermen to areas where a high catch is predicted on a given day. When fishermen cited benefits from relying on this information, the reported size of the impact for a single day ranged as high as 5-10 times the typical daily catch.[20] This information was an example of the differential impact among different groups, with larger producers more able to benefit from mobile use. The optimal fishing zones identified were predominantly located 30-50 km from shore, making it inaccessible to fishermen with smaller boats (for example fiber boats have a limit of 5-10 km and country boats, the simplest boat, have even shorter range). Also, leveraging this information typically required use of GPS equipment, which also favors larger fishermen.

4.2.2 Mobility benefits

Mobiles confer distinct advantages as a communications link in isolated circumstances. Mobile users can determine when and where they can communicate and access information. Fishermen reported benefits from mobile phones as a means of two-way communication as well as a means of access to the information service while at sea. This included dealing with emergencies and acting on weather information in time to return safely to shore. [21] Mobile use allowed fishermen to avoid potential losses to boats and nets as well as risks to personal safety. Emergency and safety benefits were consistently described as the most important impacts of the Fisher friend service. As described above, benefits were also reported from the ability to change fishing location while at sea in order to profit from the optimal fishing zone information, and form communicating to friends at sea regarding weather problems and optimal fishing zone information. Fishermen at sea reported examples of communicating with others on land to allow them to share in the benefits of a good fishing location. Importantly, therefore, the access to mobile communications amplified the value of the information provided by Fisher friend by enabling information-sharing between subscribers and non-subscribers.

Farmers also reported benefits from being able to make and receive calls while working on the farm. This included the ability to describe plant diseases from the field to experts and to coordinate better with their hired labor. 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 changing market conditions.[22]

4.2.3 Improved convenience, time and travel savings

[20] Fisher friend provided longitude, latitude and sea-depth information to identify optimal fishing zones. GPS information was important to make of the data and often the optimal zones were at a distance from shore that could be accessed by larger boats. The team did hear however, of some examples were fishermen with smaller boats were able to benefit from this information as well.

[21] One example was given of a boat that suffered an engine breakdown far from shore. While they were unsuccessful in contacting the Coast Guard despite repeated attempts, they were able to reach MSSRF staff. The staff members then contacted Coast Guard officials and a successful rescue operation was carried out.

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

Almost all of the farmers interviewed reported some benefits in terms of greater convenience such as time saving from using mobile as a basic phone. For some of the farmers interviewed the mobile represented their only convenient access to communications. This is not surprising, as fixed line communication in rural India remains extremely poor. Specifically, in Rajasthan the rural fixed teledensity is about 1% while the corresponding figure in Uttar Pradesh is less than 1%. For many of the small farmers in our survey who said they benefitted from greater convenience, the savings stemmed typically from avoiding local travel and could range from Rs. 100-200 per trip. A smaller minority said they had derived greater benefits from the ability to make better decisions about where to sell their output after getting market prices for a variety of local and distant markets.

In villages with a successful ITC rural kiosk program access to mobile phones increased the range of service of the local representative, the Sanchalak. In one case the Sanchalak reported connecting with farmers 30-40 km away. Mobile use also delivered convenience benefits to farmers who were starting to substitute some physical meetings with mobile phone conversations.[23] It was also noted that mobile was essential when the village suffered power shortages and the rural kiosk was not available. Discussions with ITC staff revealed that mobile phones did not substitute for face-to-face communication. It was reported that farmers often need highly personalized solutions that benefit from back and forth dialogue in person with the Sanchalak as well as the larger farming community. For example, a farmer may be offered a generalized solution for fertilizer application – apply two bags of phosphate fertilizer for your crop and soil conditions. He may reply that, given that he used two bags last year and there must still be some nutrients left in the ground, can he use just one bag this year? Many of the queries from farmers were could not be fully resolved by phone alone. Rather, face-to-face interactions were necessary, although aided by technology, to resolve the farmer's specific concerns through a process he trusts.

5. CONSTRAINTS

Although we found evidence that mobiles are being used in ways which contribute to productivity. But to leverage the full potential of the greater access to information enabled by mobile – 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 .

5.1 Infrastructure constraint- All seven of the focus groups involving predominantly small farmers in Uttar Pradesh and Rajasthan highlighted infrastructure gaps that affected their ability to realize productivity gains. There are four specific infrastructure constraints which limit the ability of farmers to leverage information: insufficient availability of critical resources (reduces yield); inadequate irrigation (reduces yield); poor physical access to markets (reduces realized prices); inadequate crop storage (reduces realized

[23] In one ITC village it was reported that 20% 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.

prices). Six of the seven focus groups highlighted problems such as difficulties sourcing critical resources such as fertilizer, seed and medicine. There were also concerns about the difficulties identifying bone fide products as many counterfeits are sold in local markets. In several groups the farmers noted that they needed information that would help them identify these counterfeit goods, which remain a significant productivity drain in India. [24] 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 growing desired crops.[25] Rajasthan's farmer noted that the "scarcity of water is the main hurdle for development of agriculture in the region."

Farmers reported poor road infrastructure and lack of refrigerated transport as problems affecting their access to markets. Many of the small farmers typically used small carts powered by animal or small engines to deliver their goods to market and said that transport costs represented a prohibitive barrier to accessing markets further afield. This limited their opportunity to profit from market price differences by selling at markets where higher prices may be available. As one small farmer in Allahabad commented, even if he knew the prices in larger regional market, "There were no roads that go there." Lack of storage facilities was cited as curtailing farmers' ability to choose when to sell their crop and thereby limiting options to maximize price. One group of farmers noted that lack of storage was a contributing factor to the effective monopoly of local commission agents that they believed caused them to receive lower prices for their produce.

As a counterpoint to the findings in Uttar Pradesh and Rajasthan, the farmers surveyed in the five focus groups in Maharashtra did not report infrastructure constraints outside of a limited mention of cold storage concerns[26]. There was widespread irrigation and diversification into water-dependent, high-value crops like horticulture. [27] There were no perceived concerns with availability of inputs[28] or access to markets. Not surprisingly, these farmers consequently reported greater ability to achieve both yield and price benefits from leveraging information.

ITC's internet kiosk service is one attempt to overcome some of the challenges presented by inadequate infrastructure, by combining the provision of information with other

[24] Input constraints relate not only to availability in general, but also to the availability of "genuine" inputs.
[25] 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 well 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.
[26] 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.
[27] 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 – 12 hours/day.
[28] While one focus group mentioned a desire to get information on seed availability, this appeared to be more in order to save search costs rather than difficultly in ultimately getting the product. The greatest challenge noted by focus groups was primarily around price volatility.

services such as the direct sale of critical resources. Recognizing the problems faced by the small farmers in their supply chain, the internet kiosk model includes information delivery, input provision and direct procurement. It seeks to overcome infrastructure constraints by bringing markets to the farmer. Farmers we interviewed in villages with successful ITC programs reported yield improvements and price improvements as a result of the kiosk program. The primary benefits reported were the introduction of hybrid seed varieties and adoption of new farming practices, leading to productivity gains between 10-40%. Farmers noted that by receiving comparative market pricing information as well as a firm price offer in advance from ITC, they had greater ability to choose when and where to sell their products. They also benefited from being to sell to ITC locally and getting transport costs reimbursed.

Table 6 : Example of the ITC 'e-choupal' model – Wheat in Uttar Pradesh

Problem	Examples	Solution
Lack of consistent, reliable information	• Critical resources, disease, sophisticated farming practices, accurate weather reports • market prices (in advance of market arrival)	• Information provision through e-choupal • Other services (soil-testing, advice) available through regional hubs
Lack of availability of inputs	• Seed, fertilizer, pesticide, fungicide, weedicide, medicine	• Supply of inputs provided
Access to Markets and Storage	• Crowded physical marketplace (could take 2-3 days to enter) • lack of storage (less leverage over when to sell – worse for perishable products) • Transport costs to non-local markets	• Direct procurement by ITC • Deal negotiated at time of farmer's choosing • Transport costs reimbursed
Middlemen dominate the supply chain	• Unfair practices – higher transaction costs, lower amount paid to producer	• Direct procurement • Transparent pricing known in advance • Payment based on gradations of quality

Source: Interviews, Team analysis.
Note: The specific range of services provided can vary among individual e-choupals.

5.2 Credit Constraint: A lack of formal credit can prevent purchase of important inputs and can also reduce the farmer's chances of getting the best price because of restrictions

(explicit or implicit) on where he can sell his crop.[29] 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 to price received. We heard 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.

5.3 Capacity for risk-taking: Farmers in general are naturally conservative. However in order 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 said that in their experience persuading small farmers to adopt new seed varieties or farming methods often requires a combination of approaches: repeated dissemination of information, demonstration plots and farmer dialogues. 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. It therefore seems likely that for broader rural productivity gains a set of similar capacity-building activities to complement the basic information provision will be required.

6. CONCLUSIONS

One key element is that the service providers has to leverage the benefits of mobile as that of portability, flexible content delivery capability and two-way communications characteristics 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 revolution in Indian agriculture, we could see the signs of agricultural productivity improvements, an impact which is enhanced by the new mobile-enabled information services. The most common benefit of mobile found in the research was derived from the use of mobile phones as a basic communications device as for many of the farmers interviewed it was the only convenient phone access they had. There are significant examples of a range of benefits arising from the use of mobiles in the context of rural India – not only from mobility, but also easy access to customized content and convenience.

Realization of the full potential impact of mobile phones is limited, however, by a set of constraints that prevent farmers from fully leveraging the information they receive. The barriers apply more to small than to large farmers; large farmers are more able to leverage the benefits of the communications and information they can access. The constraints include shortcomings in physical infrastructure affecting access to markets, storage and irrigation. Issues also arise with the availability to small farmers of critical products and services including seeds, fertilizers, medicines and credit. Equally, to make full use of the potential information delivered, farmers must have sufficient risk-taking capacity to be willing to experiment with the new strategies and ideas disseminated.

[29] This is sometimes referred to as the problem of "bondedness"

Social networks may play an important role in building the trust and confidence required to influence the adoption of new mindsets and actions by small farmers. In addition basic information will need to be supplemented by a range of other activities such as demonstrations and broader communications efforts.

This array of constraints means that additional interventions may be required to improve agricultural productivity growth. Increased public and private investment will be necessary to resolve critical infrastructure gaps. Policy changes may also be needed to encourage better access to high-quality inputs and credit for small 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 we found that there were still opportunities to realize productivity gains from the adoption of new farming practices and actions to mitigate crop losses. In the case of fishermen, there were, in addition to economic benefits, safety benefits and enhanced quality of life from decreased isolation and vulnerability.

There are also lessons for current and future mobile-enabled information service providers about the information of greatest value to users in the agricultural sector.

- Customization and frequent updating add substantial value. Generic information triggers dissatisfaction and reduces the frequency with which farmers access the service. The most frequent criticism we heard was that information was "old and routine".
- Secondly, where literacy concerns are not paramount, text messaging offers significant advantages over voice-based delivery in terms of convenience and content flexibility.
- Finally, information should be in the local language and any platform should be intuitive for subscribers to understand. Most of the farmers we interviewed were prepared to pay for information services as long as they felt that they would get the information they wanted – relevant, timely and reliable.

There are some important questions which were not covered by our research. One is the extent to which information is shared by farmers who use mobile phones with those who do not. As continued mobile penetration encourages more information access and diffusion, further research may be able to evaluate if ultimately a "tipping point" will be reached, amplifying the impact of mobiles on productivity and farm revenues. Finally, it may be useful to consider whether and how much mobile phones may be increasing overall market efficiency reflected in decreasing price dispersion in wholesale agricultural markets.

This study provided a first look at the potential for mobile phones to affect productivity in the agricultural sector as a whole. We saw many examples of benefits created by the characteristics of mobility, customized content delivery and convenience. As mobile penetration continues to increase among farming communities and information services continue to adapt and proliferate, the scope exists for a much greater rural productivity

impact in future, but achieving the full productivity potential will depend on reducing other constraints which limit the use of the information farmers and fishermen can obtain from their mobile phones.

References

Abraham, Reuben (2007). "Mobile Phones and Economic Development: Evidence from the Fishing Industry in India". Information Technologies and International Development, Vol. 4, No.1, pp.5-17.

Evenson, R.E.; Pray, C. and M.W. Rosegrant. (1999), Agricultural Research and productivity Growth in India. Research Report No 109. International Food Policy Research Institute, Washington, D.C:

Fan, S., Hazell, P.B.R. and S. Thorat. (1999), Linkages between Government Spending, Growth, and Poverty in Rural India. Research Report No 110. International Food Policy Research Institute, Washington, D.C:

Jensen, Robert (2007). "The Digital Provide: Information (Technology), Market Performance, and Welfare in the South Indian Fisheries Sector". The Quarterly Journal of Economics. Vol. CXXII, No. 3, pp. 879-924.

Kumar, P. and Mark W. Rosegrant (1994),Productivity and Sources of Growth for Rice in India, Economic and Political Weekly, 29 (52): A183-A188.

Kumar, Praduman and Surabhi Mittal (2006). "Agricultural Productivity Trends in India: Sustainability Issues" Agricultural Economic Research Review. Volume 19, Pp 71-88.

Mittal, Surabhi and Praduman Kumar, (2000). "Literacy, Technology Adoption, Factor Demand and Productivity: An Econometric Analysis". Indian Journal of Agricultural Economics. Vol. 55 No. 3: Pp: 490-499.

Rasher Michael. "The use of GPS and mobile mapping for decision-based precision agriculture". Internet site: http://www.gisdevelopment.net/application/agriculture/overview/agrio0011.htm

Annexure 1: Description of organisations surveyed

IFFCO (Indian Farmers Fertilizers Cooperatives Limited) a national organization of rural co-operatives, runs a mobile-enabled farmers' information, service in partnership with Bharti Airtel, an Indian mobile operator. This service is called IKSL (IFFCO Kisan Sanchar Limited). It requires the farmers to purchase a special SIM card- IFFCO-Airtel Green Card. They receive free voice-mails containing agricultural information as well as access to a paid helpline service costing Rs. 1 per minute.

Reuters. The global information services company operates an Indian-based mobile-enabled information business for farmers, Reuters Market Light (RML). Farmers purchase a 3 month, 6 month or 12 month subscription for which they receive daily agricultural information through text messages. Our field interviews were supplemented by interviews with Reuters' staff in London and Maharashtra.

ITC. The Indian agribusiness company operates several models of a rural internet kiosk program, the "e-choupal", serving farmers across rural India. The version investigated for this report was anchored upon an internet kiosk manned by a local farmer who acts as an agent for ITC (a "Sanchalak"). Through this agent, farmers can access agricultural information, buy inputs (seed, fertilizer, pesticide) and other retail products, and can sell selected crops directly to ITC. They are also exposed to demonstration plots and training sessions. There is no charge for the information and training sessions. Our field investigations were supplemented by interviews with staff in Gurgaon and Hyderabad.

MS Swaminathan Research Foundation (MSSRF). This non-governmental organization is piloting a mobile-information services model for fishermen in partnership with Qualcomm, a global technology company, and Tata Teleservices, an Indian mobile phone operator. This program, Fisher friend, provides free mobile handsets to fishermen, shared on a rotating basis, along with free access to the information service.

Annexure 2: Ranking of the use of modern technology by farmers to access information on Cultivation

Information	Use of Modern Technology [1]	Use of Mobile[2]
Seed	I	I
Mandi (Output) Price	na	II
Fertlizer application	II	IV
Plant protection	III	III
Harvesting and Marketing	IV	V
Farm Machinery	V	VI

Note: 1. Results 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.
2. Information 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'.