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Modern ICT for Agricultural Development and Risk Management in Smallholder Agriculture in India

Surabhi Mittal

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International Maize and Wheat Improvement Center

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Acronyms

APAARI	:	Asia Pacific Association of Agricultural Research Institutions
ATMA	:	Agricultural Technology Management Agency
CABI	:	Centre for Agriculture and Biosciences International
CCAFS	:	Climate Change, Agriculture and Food Security
FARA	:	Forum for Agricultural Research in Africa
GDP	:	Gross domestic product
GoI	:	Government of India
GSMA	:	Groupe Spéciale Mobile Association
HAFED	:	The Haryana State Co-operative Supply and Market Federation Limited
ICAR	:	Indian Council of Agricultural Research
ICRIER	:	Indian Council for Research on International Economic Relations
ICT	:	Information and communication technology
IFFCO	:	Indian Farmers Fertilizer Cooperative Limited
IFPRI	:	International Food Policy Research Institute
IKSL	:	IFFCO Kisan Sanchar Limited
IMD	:	Indian Meteorological Department
ITC	:	India Tobacco Company
ITU	:	International Telecommunications Union
ILRI	:	International Livestock Research Institute
KVK	:	Krishi VigyanKendras
MSSRF	:	M.S. Swaminathan Research Foundation
NAIP	:	National Agriculture Innovation Project
NGOs	:	Non Governmental Organizations
NSSO	:	National Sample Survey Organization
PACS	:	Primary Agricultural Co-operative Societies
PPP	:	Public private partnership
RML	:	Reuters market light
SAU	:	State agricultural universities
SIM	:	Subscriber identity module
SMS	:	Small message service
TRAI	:	Telecom Regulatory Authority of India
VAS	:	Value added service

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For the case studies we took information from the respective websites of the models studied; namely case studies, popular articles, published and unpublished documents shared by the organisations, and detailed interactions with the key resource people in these organisations and their partners. We would like to thank everybody for their input and efforts. For information about IKSL we used its website www.iksl.in and are grateful to Mr. Shrotriya, Mr Sudhakar and other team members of IKSL for sparing their time for discussions on IKSL. For the case study on RML (www.reutersmarketlight.com) we are grateful to Mr .Amit Mehra and Mr. Rantej Singh for helping us with information on RML. The information provided in the case study on Kisan Sanchar is based on the author's discussions with Mr. Kamal Jeet and Ms. Shveta Gupta. We are thankful to them and to their promoters Dinesh Miglani and Deepak Miglani for the insights they provided.

Executive summary

Usually the agricultural sector, and in particular farmers, are highly vulnerable to risks due to high variability in climatic conditions and to market uncertainties. The farmer's exposure to risk and uncertainty is often aggravated by lack of information about weather, inputs, farm management practices or market prices, and this lack of information has an adverse impact on crop production and income. Some of these risks, for example the risk of a bad monsoon, affect agriculture as a whole, while other risks vary from region to region, and the severity of their effect depends on an individual farmer's knowledge and ability to cope. The evidence suggests that a farmer who receives quality, up to date information, and who has the ability to use that information, is able to lessen the effect of these risks.

Production Risks: all farmers face production risks irrespective of their location and crops due to uncertainty of rainfall, variability in temperature and bad or unpredictable weather conditions. These factors can variously lead to soil erosion, poor soil quality, increased incidences of pests and diseases and low yields. There is a need for fundamental information about expected weather conditions, and about general know-how: which crops to plant, which seed varieties to use, what the best cultivation practices and farm management practices are for that area, and the best suitable technology available locally.

Market Risks: these arise either from over- or underproduction, leading to a discrepancy between supply and demand. An inadequate supply of inputs, for example seed or local labor, will lead to an insufficient yield for market requirements, whereas overproduction will impact unfavorably on the market price. Lack of market information such as prices, demand indicators and logistical information can lead to higher production costs, increased transportation costs, higher information search costs and can also affect wages.

The overall goal or expected outcome of this research is to see the potential of modern Information and Communication Technology (ICT) to improve yields and income, and to disseminate knowledge to farmers to help them manage risk in an informed manner. It is expected that modern ICT can play a role in bridging the information gap, and in reducing the information asymmetry that exists between farmers and between regions. The delivery of information through mobile phones has the potential to deliver localized content rapidly, and can thus enhance the dissemination of knowledge and information on technologies, inputs, markets and prices, and help in better risk management. This can act as a catalyst to enable better adoption of improved technologies, seed varieties, and farming practices (Mittal and Tripathi, 2009).

The major objectives of this scoping study are:1) to analyze the scope and potential of the use of ICT, especially mobile phones, for farmers and the agricultural sector; 2) to identify farmers' present sources of information and information networks, and to identify the information needs that help them to mitigate production and market risks; 3) to identify existing ICT-based innovations in the agricultural sector, the key players, and the institutional arrangements for the dissemination of information;4) to highlight selected models and innovations in the form of case

studies; and 5) to identify the constraints and challenges and to suggest key questions that should be taken up for research based on this scoping study. This study was carried out as a combination of desk study for analyzing the literature reviews and secondary data sets, and interviews for the case studies.

It has been found that among modern ICT modes, mobile telephony has been the 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 of content-specific information, and also helps to improve awareness, education, the better adoption of technology, better health and efficiency, reduced transaction costs, greater market efficiency and better climate-linked risk management. These in turn catalyze rural-sector development and economic growth.

The research reviewed existing literature and found evidence that mobile phones are being used in ways which contribute to productivity enhancement along with risk management. The contribution has been felt in different ways, for example there has been an increase in the adoption oftechnology, which has had a beneficial impact on the livelihood of farmers in terms of obtaining good prices or access to market information, as well as reduced wastage and lower transaction and search costs, thereby increasing efficiency. Realising the full potential use of mobile phones will require significant improvements in the supporting infrastructure, and also in capacity-building, particularly for small farmers, to enable them to use the information they access more effectively. There are other constraints that hinder the impact of these models, for instance the scattered nature of ICT-based models, which tends to exclude poor farmers and those living in remote areas.

To strengthen these findings from literature, three case studies:Indian Farmers Fertilizer Cooperative Limited (IFFCO's) Kisan Sanchar Limited (IKSL), a voice-based model; Reuters Market Light (RML), an small message service (SMS)-based model; and Kisan Sanchar, a model which is both SMS-and voice-based, were analysed in depth to assess how modern ICT tools, particularly the mobile phone, have been used to meet the information needs of farmers, what institutional mechanisms have been put in place to provide information to farmers, and the impact that such services have had on farm income and output.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. The effectiveness of ICT in passing on information to farmers, particularly small landholders, holds the key to its successful utilization as a complementary dissemination mechanism for extension services.

1. Introduction

Indian agricultural growth is hindered by low productivity, a shrinking agricultural land base, urbanization, diversification in production and consumption bases, poor market linkages and other factors. In these circumstances the challenge for the government and policy makers is to regain the dynamism in agricultural growth of around 4% that was evident in the late 1970s, and to strike a balance between policies for food security and policies to improve the income levels of farmers.The vagaries of nature, unpredictable weather conditions, and uncertain prices, along with an inadequate supply of labor, have further increased uncertainties, creating an adverse impact on productivity.

Two major developments have affected the growth of the agricultural sector in India since the 1990s.One has been the stagnation in public investment, and the other has been the breakdown of extension services that has led to large gaps between the yield from experimental farms and the yield from farmers' fields. Insufficient extension services and poor access to information have 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 (June, 2005), GoI, reveal that only 40% of farming households have access to information about modern farming technologies. The cost of delivering information face-to-face in the public sector is very high. Overall, poor access to information, crumbling extension services and poor market information result in low productivity and slow uptake of technology.

Extension services in India have primarily been the responsibility of the public sector. The government has huge research and development infrastructure in the form of institutions such as the Indian Council of Agricultural Research (ICAR), State Agricultural Universities (SAUs) and *Krishi Vigyan Kendras* (KVKs- Agriculture Research Stations). Extension services help to fill these gaps between yields by disseminating information regarding the technology relevant for the farmer's geographical area and cropping system, and by recommending the appropriate quantity and quality of inputs and their timely use. They also educate farmers about good agricultural and crop management practices, and help in providing coping strategies to farmers in times of disastrous climatic conditions. Public sector extension services in India are usually criticized for their ineffective targeting, poor reach, and the huge administrative cost of delivering information.

The Indian extension system has undergone reforms since the late 1990s and has experienced major conceptual, structural, and institutional changes (Raabe, 2008). These changes were undertaken to improve the efficiency, effectiveness and timeliness of services. The reforms included the forging of partnerships between the public and private sectors (PPPs) to provide extension services, and the strengthening of the linkages between researchers in laboratories and farmers in the field .ICT-based extension services provide an opportunity to further strengthen these linkages. Projects like the Agricultural Technology Management Agency (ATMA) e-sagu and e-choupal gave the initial thrust, and in the decade since, extension services have moved to the use of mobile phones and web portals to deliver information and technology.

Changes in consumption patterns leading to cropping-pattern changes, increasing globalization and commercialization, and climate changes resulting from global warming have all led to a change in farmers 'need for new technology and knowledge. Farmers now have access to a number of new farming technologies, for example different seed varieties, but they face new constraints of land, labor, capital and information. Consequently, extension services have to be fine-tuned to meet the changing requirements. They have to play a role in the transfer and diffusion of technology, create appropriate interventions and become involved in innovations that strengthen the extension system.

This crumbling extension network can be strengthened by the use of ICT in disseminating agricultural information to the target audience – farmers. Although the cost of delivering information through ICT to farmers also needs a huge investment, this is to an extent offset by the large number of potential users and its sustainability over a long period (Kumar, 2005).These initiatives are usually operational in a PPP mode. The sustainability of these extension models depends on the benefits generated and the efficient functioning of support from all the stakeholders in the system.

The introduction of ICT can bring about a difference in the development of institutions and instruments. Access to ICT can have a tremendous positive impact on sustainable development and poverty reduction (Torero and Braun, 2006). Although there is little doubt that information and knowledge can affect poverty reduction and can be a driver of economic growth, empirical evidence on this is still missing (Bhavnani etal., 2008). There is a strong correlation between high Gross Domestic Product (GDP) per capita and mobile telephone penetration in a country.ICT use has yet to demonstrate its role in the efficient provision of public goods and services, particularly in low-income countries. Weak institutions inhibit the realization of the potential of ICT. Therefore it is important that institutional aspects are studied to assess how these institutional interventions can be used to maximize direct benefits to the poor.

The Rashid and Elder 2009 study explores the development impact of mobile phone usage and concludes that mobile phones do offer a potential for application, and show evidence of having a positive effect on the lives of the poor, and do contribute to greater efficiency for farmers and fishermen. However, it also cautions that if we do not have a clear understanding of the need, skill requirements, applicability and the environment that needs to be created to use modern ICT, then there are chances that this might turn out to be a "white elephant".

The application of ICT in agriculture is not a new concept. But the use of modern tools of ICT like the internet, web portals and mobile phones isin its initial stages and thus it is important to understand how ICT is used in agriculture, how we expect ICT to play a crucial role in meeting farmers' needs and in improving their adaptation to climatic changes, and what potential tools of ICT can be used to do so. The NAIP Initiative (National Agriculture Innovation Project) of the Indian Council of Agricultural Research (ICAR), Government of India (GoI), has also pointed out the need for a comprehensive assessment of major ICT initiatives in the country in order to understand their successes, failures and gaps. This will help suggest the way forward in terms of the design and implementation of ICT initiatives to ensure that they meet farmers' expectations

and needs so that they can better manage risk. This goal acts as the guiding principal for undertaking this scoping study.

The major objectives of the scoping study are to:

1. Analyze the scope and potential of the use of ICT, and especially mobile phones, for farmers and the agricultural sector
2. Identify farmers' present sources of information and information networks and to identify the information needs that help them to mitigate production and market risk
3. Identify existing ICT-based innovations in the agricultural sector, the key players and the institutional arrangements for the dissemination of information, by studying selected models and innovations in the form of case studies
4. Identify the constraints and challenges, and suggest key questions that should be taken up for research based on this scoping study.

2. Methodology

A scoping study is planned as a research exercise before the formulation of a detailed research project, and is essentially a background document that informs the implementation of a new research project. It helps to map the key concepts underpinning a research area and the main sources and types of evidence available (Arksey and O'Malley, 2005). This scoping study was carried out as a combination of desk study for analyzing the literature reviews and secondary data sets, and interviews for the case studies.

Objective 1- The scope and potential of the use of ICT is analyzed on the basis of the literature reviews of studies mainly from South Asia and Africa to support the findings. These studies were chosen from literature which deals directly with the use of modern ICT tools like the internet or mobile phones, and has demonstrated evidence of its impact on farmers' adoption of technology, impact on output prices and marketing, and impact on search and transaction costs. These results are divided into three subsections and presented in section 3 of this study.

Objective 2 -The data set of the National Sample Survey Organization (NSSO)'s Situation Assessment Survey of Farmers, 2005,was used for analysis, and the results are presented in Section 4.This data was obtained from the report of NSSO no. 499, and was collected by the Union Ministry of Agriculture, GoI, through a survey of 51,770 households spread across 6,638 villages of India. This report presents results across states and at all-India level on access to modern technology for farming by farmer households, on the proportion of households accessing various sources of information on modern agricultural technology, such as training programs, KVKs, extension workers, input dealers, other progressive farmers, radio, television, and so on. Further, for each source of information it gives the breakdown of households by frequency of contact with the source of information and the nature and quality of the information obtained. Time series data on country-level ICT indicators was also collected from the Telecom Regulatory Authority of India (TRAI) and the International Telecommunication Unions (ITU).

Objective 3 - For analysis of objective 3, all major ICT-based models used in the agricultural sector of India were listed and then three major models were chosen for case studies. These case studies assess how mobile phones are being used to meet the information needs of farmers, the institutional mechanisms that have been put in place to provide information to farmers, and the impact such services have had on farm income and output. For the case studies we interviewed the operational managers, content managers and partners of these services, and the interviews were further supported by the documents provided by service providers. These results are presented in section 5 of the study.

Objective 4 - This was achieved largely by drawing inferences from the literature reviewed and the case studies. Constraints and challenges were identified and research gaps listed as the key researchable issues. With the help of literature review, case studies, and secondary data, the researchable questions for a bigger project in future were outlined, and an attempt was made to lay out a map of activities that could be undertaken following the scoping study. This is presented in section 6 of the study.

3. Literature review

Research, extension, literacy and infrastructure have been identified as the most important sources of growth in productivity (Kumar and Rosegrant, 1994; Mittal and Kumar, 2000). An improvement in standards of rural literacy leads to growth in the adoption of technology; the use of modern inputs like machines and fertilizers improves yield (Mittal and Kumar, 2000; Kumar and Rosegrant, 1994; Evenson et al., 1999; Fan et al., 1999; Singh, 2002). With increase in climatic variability as the production and market-linked risks increase, investment in irrigation, research, extension and rural infrastructure (roads and electricity) is needed to increase productivity and strengthen the agricultural sector in India and it is also necessary to improve the delivery of information and knowledge to farmers. The literature reviewed in this section highlights the fast growth of mobile telephony in the emerging economies of Asia and Africa and its key role in reducing information search costs and asymmetries and increasing market efficiency, thus reducing the risks and uncertainties faced by farmers.

3.1 Impact on adoption

The World Bank's independent evaluation group has made certain observations on agricultural extension in India:1) farmers who regularly connect with extension staff are more likely to adopt technology sooner;2) it is a fact that progressive farmers form connections with extension agents faster than other farmers;3)technology that provides quick returns is likely to be accepted earlier and faster. If these three observations are taken as facts, modern ICT can be used as an efficient tool to enable non-progressive farmers to connect to extension information and to make them adopt technology faster. ICT can play an important role in the adoption of technologies that are in an early stage of development like no tillage and the genetically modification technology revolution (Fischer et.al., 2009). Ali and Kumar (2010) examined the impact of India Tobacco Company (ITC's) e-chaupal on decision making by farmers and did a comparative analysis of users and non-users. They found that education, social categories, income and landholding size are important factors that influence the use of ICTs in decision making.

De Silva et.al. (2010) quantitatively measured the influence of mobile phone adoption at the bottom of the pyramid population (lowest income deciles population) in six countries (Bangladesh, Pakistan, India, Sri Lanka, the Philippines and Thailand). The study found evidence that the mobile phone helps in generating better social and business networks and thus helps in the faster spread of knowledge and technology. Muto and Yamano's (2008) study on Ugandan maize and banana farmers also shows that, over the years, the adoption of mobile telephony and its use in agricultural activities has led to a reduction in poverty. It is often seen that remote regions are high in poverty, and increased connectivity in these regions is likely to reduce poverty. Although 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.

3.2 Impact on price

One of the perceived benefits of modern ICT is greater access to information about markets and prices. It is expected that price information will have a beneficial impact by improving the bargaining capability of farmers with traders, thus enabling them to realize better prices and by reducing arbitrage, wastage or spoilage (Mittal et al., 2010). Fafchamps and Minten's (2011) paper estimated the benefit of information on markets and weather conditions 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 on the 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; Abrahim, 2007; Mittal et al., 2010; Aker, 2008; Goyal, 2010). However, none of these studies have done a rigorous quantitative analysis to evaluate the impact.

Other studies like those of Aker (2008) and Muto and Yamano (2009) demonstrated the positive gains in prices due to the introduction of mobile phones, but this was more evident in the case of commodities or in regions where price information asymmetry was very high, or where the markets were not well developed for specific high-value commodities. In these cases, price information played an important role. The expansion of mobile phone networks and increase in mobile density in Uganda has enabled higher market participation by farmers producing perishable crops like bananas and has helped them to realize higher prices by reducing the information asymmetry that existed between farmers and traders (Muto and Yamano, 2009). Mobile connectivity, particularly in the remote areas of Uganda, is said to have resulted in a 20% increase in banana sales. Aker and Fafchamps' (2010) paper estimated the impact of the use of mobile phones on farm-gate agricultural price dispersion in Niger. The results showed that the introduction of mobile telephony reduced producer price dispersion for cowpeas by 6%, and that the effect is stronger for markets that are farther apart and for those linked by unpaved roads.

The results from these studies emphasize that the introduction of mobile telephony or mobile-enabled agricultural information services have a higher impact in regions which are poorer and are remote from markets. This might be a reason why Fafchamps and Minten in their 2011 paper, which had Maharashtra, a developed state, as its study area, found that the services provided by RML did not have much of an impact. 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.

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 is noted that realizing potential efficiency depended on easy access to capital. Similarly, Mittal and Tripathi, (2009), also noted that the potential benefits of the flow of information have been obtained mainly by large farmers in the various states of India. This is because 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.

3.3 Reduced wastage, transaction and search costs

Using mobile phones at sea, fishermen are able to respond quickly to market demand and prevent wastage from the catch – a common occurrence before the adoption of mobile phones. (Jensen, 2007; Abraham, 2007). Mobile phones help to 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. Better communication with social networks helps in times of shock and reduces risk to households. (Aker and Mbiti, 2010).

The logical starting point for understanding 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. The study of De Silva and Ratnadiwakara (2008) showed that at different stages of the agricultural value chain, farmers – mainly smallholder, vegetable producers in Sri Lanka – could reduce their search and overall transaction costs because mobile telephony improved their decision-making ability. 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 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 helped to 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 in their 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. The Aker and Mbiti study also shows that mobile phones improve co-ordination among agents, and increase market efficiency by allowing better communication and better management in the supply chain.

3.4 Scope and potential - synthesis

Overall, the use of mobile phones has been found to encourage poor farmers towards greater market participation and diversification into high-value crops. This change has helped to increase farm earnings through higher price realization and reduction in wastage.

The contribution of ICT can be felt at all stages of the agricultural cycle; the impact has been in terms of both quantifiable gains (increase in income, improved yield etc.), and non-quantifiable gains (social benefits of improved communications, information about education and health etc.) (Bhatnagar, 2008).Information is one of the key inputs to productivity growth (Anderson and Feder, 2007). The farmer's demand for information is seen as a productive input, and thus depending on how productive or useful the information is, the farmer is willing to purchase that input. Therefore, different delivery systems will have different values depending on the kind of information being delivered, (e.g. availability of inputs, new seed varieties, input prices, weather information, future prices, ways of using inputs etc.).

Most governments all over the world realize the importance of real-time information and thus innovative mechanisms to deliver information to farmers are being developed. An APAARI (Asia Pacific Association of Agricultural Research Institutions, 2004) study on Asia Pacific shows that since the 1990s, agricultural extension systems have significantly weakened and their effectiveness has reduced, primarily due to a decrease in funding for agricultural development. Although investment in agricultural sector-based ICT initiatives is low, with private-sector intervention, a number of such initiatives are being developed and implemented in various Asian countries, and more specifically in India. The new initiatives in the use of ICT include community radio, SMS and voice-based cellular telephony, information through tele-centers, internet kiosks, village knowledge centers, multipurpose community centers etc. These new ICT initiatives are transforming the traditional agricultural extension system, but the mobile- and internet-based information delivery models have to be complementary to conventional extension services (Mittal et al., 2010). These new ICT models still lack appropriate network linkages with research institutes and other knowledge banks which are a possible source of appropriate content for the customized, timely information that is necessary for the smooth flow of information to farmers to help them to mitigate risk.

There are a number of studies that have demonstrated the use of ICT in disseminating knowledge and technology to farmers, but there are concerns about the limited understanding of the impact of this intervention on the behavior of farmers, and its capacity to act as an enabler of technology adoption (Ali and Kumar, 2010; Aker 2010).

4. Information needs and networks for mitigating risk

As discussed above, access to information is identified as one of the key enablers of enhancing agricultural productivity growth. So far, various formal and informal networks are used by farmers to get agriculture-related information for managing agricultural risk, both before and after the risk has occurred. But the applicability as well as the coverage of these sources remain limited and have different effects across states and farmers. This section lists the various existing information networks and sources used by farmers and also the types of information they deliver.

4.1 Information networks

National Sample Survey Organization (NSSO2005) has documented that at the all-India level, only 40% of farmer households have access to one or more sources of information (NSS, 2005). The NSS[2] found that of the sixteen different sources for accessing information on modern technology for farming, about 16.7% of the farmers got their information on a daily basis from other progressive farmers in their villages. Farmers also consider input dealers (13.1%), radio (13.0%) and television (9.3%) as important sources of information (Table 1). This survey was conducted from January to December 2003; mobiles were then not used as a source of information. The survey covered 51,770 households spread over 6,638 villages across the country.

These numbers also emphasize the fact that extension workers and the public extension system were accessed by only 5.7% of farmers. At the state level also, the percentage of farmers accessing extension workers was very low. A large interstate disparity existed in respect of access to information from extension workers; for instance only 0.4% of the farmers in Bihar were approaching the extension workers for information, while for farmers in the state of Chhattisgarh it was15.5%. One important reason for these interstate disparities is that the extension workers and their linked organizations are organized differently in each state, with a wide diversity in personnel numbers and program focus. The ratio of staff to farmers varies widely across the country (1:300 in Kerala, 1:2,000 in Rajasthan) (Raabe, 2008). Another reason may be how well other sources of information are developed in that state. We again take the example of the same two states: Bihar where the access to extension workers is low, has fairly good access to radio (17.3%) while in Chhattisgarh all other sources of information are not very efficiently used by farmers. In relation to overall access to any source of information, the highest percentages are found in the state of Andhra Pradesh (62.7%) and West Bengal (60.9%). Even in these states, the percentage of farming households accessing information through 'other progressive farmers' and 'input dealers' was highest (Table 1).

[2] The survey evaluated actual access as opposed to ability to access.

Table 1. Percentage of farmer households accessing modern agricultural technology through different sources of information at state level.

State/UT	Extension workers	Television	Radio	Newspaper	Input dealers	Other progressive farmers	Any source
Andhra Pradesh	9.0	11.9	3.9	6.4	30.1	34.1	62.7
Assam	5.9	9.3	28.9	10.2	8.0	15.9	46.1
Bihar	0.4	3.4	17.3	5.7	12.4	10.0	32.4
Chhattisgarh	15.5	4.2	3.5	1.6	0.2	3.3	25.0
Gujarat	21.9	10.4	6.2	6.8	24.3	30.0	55.2
Haryana	2.5	9.0	11.2	8.0	9.5	16.9	37.0
Jammu & Kashmir	3.0	30.0	36.3	1.9	1.3	0.7	48.0
Jharkhand	0.0	2.3	15.4	4.7	3.1	8.7	28.4
Karnataka	11.5	11.9	14.2	9.8	15.5	11.4	44.3
Kerala	3.8	22.6	30.6	37.8	2.8	13.0	58.0
Madhya Pradesh	9.0	6.6	8.4	3.4	10.2	19.1	41.4
Maharashtra	7.6	20.9	12.6	14.6	17.1	17.0	46.2
Orissa	6.3	6.1	6.0	3.9	8.2	7.0	25.6
Punjab	1.4	16.5	5.4	8.1	3.6	4.3	26.7
Rajasthan	1.4	2.1	2.8	2.1	5.6	5.3	14.7
Tamil Nadu	13.3	19.6	16.3	14.3	9.4	21.0	50.0
Uttar Pradesh	1.1	6.5	15.0	4.0	8.3	18.9	33.6
West Bengal	4.1	6.6	20.8	5.6	35.6	24.7	60.9
India*	5.7	9.3	13.0	7.0	13.1	16.7	40.4

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 information from each source.

A study by e-Arik (Saravanan, 2007b) for villages in Arunachal Pradesh showed that the radio is the main source of agricultural information for a majority of farming households (68%). Only 9%of individuals had access to mobile cell phones. The NSS of 2003-04 did not have questions on mobile phones. While a higher percentage, (32.5 %), of farming households has access to extension workers on a seasonal basis, most farmers access traditional modes of communication, (television, radio and newspapers) on a daily or weekly basis to meet their information needs. Other progressive farmers and input dealers are contacted by farmers mainly seasonally and when need arises (Table 2).

Table 2. Percentage of farmer households accessing information on modern agricultural technology by frequency of contact, for different sources of information.

Source	Percentage of farmer households					
	Daily	Weekly	Monthly	Seasonal	Need based	Casual
Extension worker	1.5	7.6	13.1	32.5	24.2	20.3
Newspaper	41.6	20.8	3.7	5.9	9.3	17.9
Television	34.3	23.4	4.4	7.4	7.9	22.3
Radio	37.6	22.3	4.3	6.2	8.5	20.7
Input dealer	2.3	2.0	4.0	34.1	51.8	5.3
Other progressive farmers	8.4	8.4	3.8	20.3	47.2	11.8

Source: Computed from NSSO, 2005

The Indian Council for Research on International Economic Relations (ICRIER) study (Mittal et.al., 2010), also found that most farmers have access to a variety of traditional sources of information, (television, radio, newspapers, other farmers, government agricultural extension services, traders, input dealers, seed companies and relatives), which they regularly access for agricultural information. Another important source of information that farmers have been adopting recently is modern ICT (this includes mobiles or internet-based models). Results of the already established ICT-based models suggest that ICT has substantially helped farmers in mitigating risk by giving them information about weather, market prices, inputs etc. The use of mobile phones for getting information has substantially reduced the cost of gathering, processing and disseminating information on time and thus has enabled farmers to cope with disasters by giving early warnings, and in some cases advice to take action, thus reducing potential losses.

4.2 Information needed to mitigate risk

In order to provide information about weather conditions, the occurrence of natural disasters (for instance floods, drought, a tsunami), or about market prices or government policies etc., a knowledge of the specific data about the farmer, his land and his crop is a prerequisite. Lack of information increases the risk and uncertainty that the farmer faces on a day-to-day basis. Information can play an important role in mitigating the farmer's production and market risks

Production Risks: all farmers face production risks irrespective of their location and crops due to uncertainty of rainfall, variability in temperature, and bad or unpredictable weather conditions. These factors can variously lead to soil erosion, poor soil quality, increased incidences of pests and diseases, and low yields. There is a need for fundamental information about expected weather conditions and about general know-how: which crops to plant, which seed varieties to use, what the best cultivation practices and farm management practices are for that area, and the best suitable technology available locally.

Market Risks: these arise mainly from either over- or underproduction leading to a discrepancy between supply and demand. An inadequate supply of inputs, for example seed or local labor, will lead to an insufficient yield for market requirements, whereas overproduction will impact unfavorably on the market price. Lack of market information such as prices, demand indicators, and logistical information can lead to higher production costs, increased transportation costs, higher search costs and wages.

Within these broad categories, farmers' specific information needs vary according to the cropping system, soil type, weather, and location-specific characteristics. The NSS survey shows that farmers with access to information from any source look mainly for information on improved seed varieties, fertilizer and plant protection (Table 3). The farmer mainly contacts other progressive farmers and input dealers for this information, as well as gathering information from the radio, where specific agriculture-related programs are transmitted covering these aspects.

Table 3. Percentage of farmer households obtaining information on cultivation through different sources of information and distribution of such households by type of information received on cultivation at all-India level.

Various source of information	Percentage of such households accessing information on different cultivation needs			
	Improved seed/ variety	Fertilizer application	Plant protection	Other aspects
Radio	44.5	29.3	15.8	10.3
Input dealer	39.1	41.2	13.9	5.7
Other progressive farmers	39.6	31.3	15.1	14
Any other source	59.6	49.4	24	-

Source: Computed from NSSO, 2005

Similarly, the ICRIER study (Mittal et al., 2010), also shows that of the range of information that farmers required, small farmers prioritized weather, plant protection (disease and pest control), seed information and market prices. Information about market prices is valuable not only in deciding where and when to sell, but also in deciding the cropping pattern. Weather information is particularly important for most small farmers. Rainfall information is critical at certain key junctures of the cropping cycle – during planting, for timing the application of fertilizer/pesticide, and during harvesting/storage. Information on how to diagnose and treat disease is important for farmers. Plant disease, which could wipe out the entire crop, is one of the biggest challenges that farmers face. According to farmers, getting an accurate diagnosis and timely cure remains a major challenge. In some cases, farmers had access to pesticide company specialists or agricultural extension workers who would visit farmers in the field, but this was not consistently true. The study also noted that often the expertise needed to diagnose plant disease was not available locally and there were no clear channels to tap into regional or national expertise.

Three kinds of information on pesticides and other inputs were cited as highly valuable to farmers – they need to know what inputs to use for their specific requirements, how best to apply these inputs, and where they can find the specified inputs. This need for information covers seed varieties, fertilizer, pesticides, weed killers and other plant remedies. While farmers are interested in other categories of information such as the best cultivation practices and crop choice, these are not usually crucial information requirements.

Although farmers accessed information from traditional or commonly-available sources, at present the perceived quality and relevance of the information provided by these sources are highly variable. Consequently, most farmers feel that there is a lack of access to consistent, reliable information for many of their needs (Mittal and Tripathi, 2009).Thee-ARIK study by Saravanan (2007a) also assesses the farmers' information needs in the villages of Arunachal Pradesh. Information on seed varieties, seed treatment and pest management is what is most often sought by farmers.

Information needs are growing rapidly with the introduction of modern technology, hybrid seed and changing climatic conditions. During the interactions with farmers it was observed that farmers are willing to adapt to the changing environment. Farmers feel that their traditional knowledge, experience and ability are not very effective in making decisions for day-to-day activities in changing circumstances (Mittal et al., 2010).

5. Evolution of modern ICT in agriculture

The NSSO survey of Indian farmers presented the farmers' perspective on existing extension services. Among the issues raised by farmers were the need to improve the quality, reliability and timeliness of information, the need to increase the frequency of demonstrations, the need to improve the quality of presentation, and the need to improve the professional competence of the information provider. Improvements in the quality, reliability and timeliness of information were a matter of primary concern. Some of these issues can be resolved by using ICT as indicated by the use of internet-based and mobile-enabled agricultural services to deliver extension services in many areas today. The increasing penetration of mobile networks and handsets in India presents an opportunity to make useful information more widely available (Figure1).

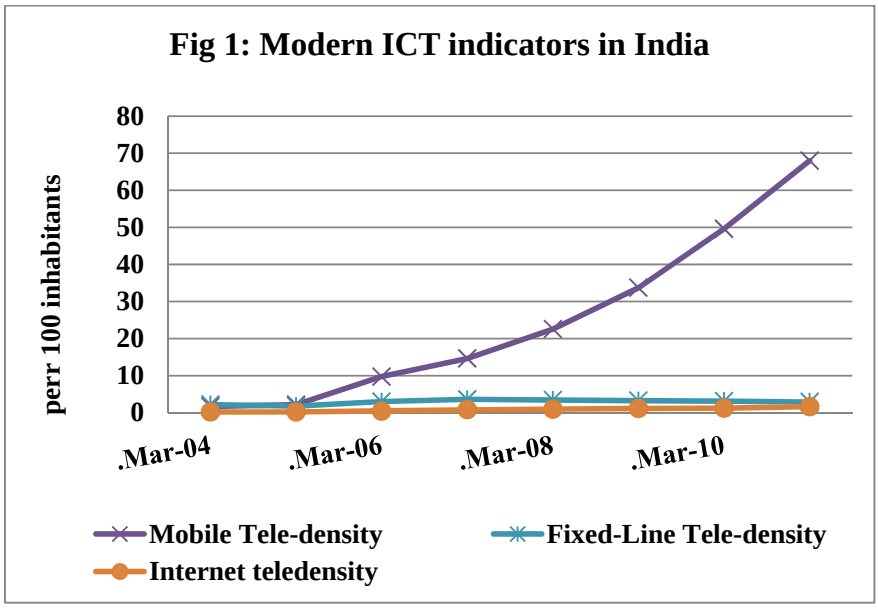

Fig 1: Modern ICT indicators in India

Source: International Telecommunication (ITU) and Telecom Regulatory authority of India (TRAI)

In India, some of the very first models to use modern techniques were the Kisan (farmers) call centers and village knowledge centers that were based on landlines and internet-based computer centers in villages for farmers to get information . These were initiated mainly by the government or by NGOs. These modern communication modes were replaced later by mobile telephony to create awareness and deliver information.

Figure 2 demonstrates the various models used to deliver agricultural information and how they evolved over time. This figure shows how, slowly but gradually, technical innovations are being incorporated into service delivery systems. Another 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. In the last couple of years there has been an increased emphasis on mobile-based information delivery systems because of increasing mobile phone penetration and increasing mobile-based service-delivery models developed by both the government and the private sector.

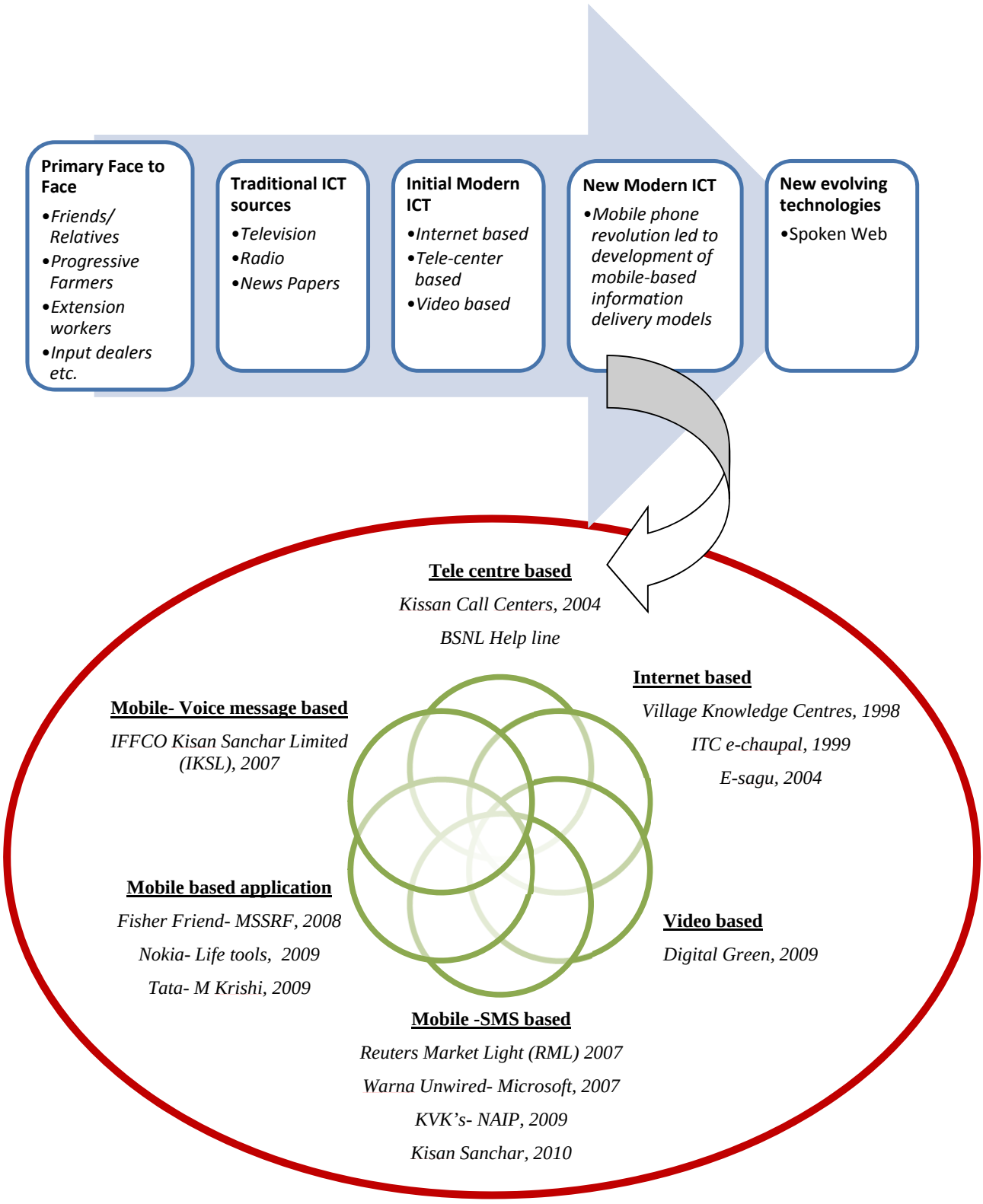

Fig 2: Evolution of information sources to farmers and selected operational modern ICT models in India.

The latest addition is an application developed by International Business Machines Corporation (IBM) that can help in delivering digital information through mobile telephony that targets the semi-literate and illiterate segments of the population. This new and evolving technology, called spoken web[3], allows people to access the World Wide Web (www) in the form of voice messages on any phone. Trials are ongoing with 40 farmers in Gujarat and soon the technology will be available to all, after the challenge of translating the content into localized language is successfully met.

A complete list of various modern ICT-based programs operating in India is presented in Appendix A1. To make the extension-services delivery sustainable, beneficial and effective in its reach to target farmers, it is important to learn lessons from these various initiatives that are operational – from their failures, constraints and their evolution in terms of institutional innovations undertaken – and also to study the potential of new evolving technologies to be integrated with either the primary modes of extension or with modern ICT modes. Evidence on the cost-effectiveness and sustainabilty of these new models is still not available. These are some of the common issues that need to be examined in future studies.

From the various operational modern ICT-based models (Figure 2), three modern ICT models are presented as case studies in this section. We discuss in detail IFFCO's Kisan Sanchar limited (IKSL), a voice-based model, Reuters Market Light (RML), an SMS-based model, and Kisan Sanchar, an SMS and voice-based model. As well as describing their institutional structure, functioning and operations, this section also attempts to see if the content of information transmitted through these models follows the three golden rules of timeliness, localized content and relevant content**.** Are farmers able to understand these messages? Do farmers take action on these messages? How does this information affect income and yield? Are these models sustainable and do they generate demand for the product (information)?

The basic parameters of any mobile-based information delivery system are that it should have efficiency in delivery, relevance in content and firmed-up content calendar for timely delivery. In order to be effective and efficient, the messages delivered through the system have to be actionable. The system should also be able to create awareness and give alerts in case of emergencies. The messages do not necessarily have to contain technological details, but should be such that the farmer should be able to take action on the information received. The most important benefit of mobile-based information is that it facilitates two-way communication between the information provider and the farmer.

[3] http://techtimely.wordpress.com/2011/03/05/ibms-spoken-web/

5.1 IKSL – Voice message based model

IFFCO Kisan Sanchar Limited (IKSL)

5.1.1 Overview

IFFCO Kisan Sanchar Limited (IKSL) is a joint venture promoted by IFFCO and Airtel in 2007. The aim of this venture is to empower people living in rural areas by providing them with information and services that will help improve their decision-making ability. The medium of promoting this information delivery is the mobile phone. The major challenge it faced was to deliver location-specific, time-sensitive information and important alerts to farmers directly, rather than through an intermediary. It also had to ensure that information delivery did not add to farmers' costs. IKSL is leveraging the benefit of the mobile phone in the hands of the poor farmers and converting it to a "dynamic house of knowledge".

5.1.2 Services

Through IKSL value-added services (VAS), every rural subscriber receives five voice messages on their mobile phones in the area of their interest at no charge. The farmers also get support from a helpline, which is managed by agriculture graduates and is connected to agriculture experts from different areas of specialization. These experts are connected to the farmers through teleconferencing facilities at the helpline. Besides individual farmers, various crop-specific communities of farmers with common interests and issues have also been formed. There are more than 10 such communities, many of which are supported by other partners and NGOs to facilitate the delivery of precise information (Table 4).

Table 4. List of IKSL Focused Communities.

Community	State	Collaboration	Starting date	Closing date	Number of subscribers
Goat Rearing Women's Community	Tamil Nadu	Vidiyal	June, 09	Continuing	550
Basmati Grower Contract Farmers Kharif 2009	Haryana	HAFED	July, 09	30-Nov	816
Horticulture Community – National Horticulture Mission	Uttar Pradesh (East)	IFFCO	June,10	Continuing	215
Ahmednagar Farmers Community	Maharashtra	Department of Agriculture	June,10	Continuing	1025
Basmati Grower Contract Farmers Kharif 2010	Haryana	HAFED	June,10	Nov.10	620
Vegetable Farmers	M.P.	IKSL	August,10	Continuing	334
Rubber Community	Kerala	IKSL	August,10	Continuing	219
Soil Health	Uttar Pradesh (East)	IFFCO	Sepember,10	Continuing	655
Farmers Club	Rajasthan	NABARD	October,10		
Sweet Corn Growers	Maharashtra	Farm Fresh Food	In process of formation		
Wheat Seed Growers	Haryana	HAFED	October,10	Continuing	600

As of December 2010, IKSL has more than 1.2 million active users of their services. The IKSL services are spread over 18 major states of India.[4] These are managed by 17 content managers and 59 experts. IKSL initiated its services in June 2007 from Eastern Uttar Pradesh.

Figure3 demonstrates a schematic flow of the services provided by IKSL to farmers. The services provide for two-way interactions between farmers and IKSL experts. A farmer receives information through voice messages on his mobile in a preferred local language[5] on various subjects related to the crops that he cultivates. The farmer can then have access to a helpline service to get answers to further queries on that topic and to give feedback to IKSL. The message content is sourced from the knowledge databases of IKSL and its partners.

Fig 3: IKSL VAS platform

Since its inception in July 2007 until December 2010, IKSL has delivered over one hundred thousand voice messages (Table 5) to farmers, covering a wide range of issues in areas such as soil management, animal husbandry, weather, plant protection, market rates etc. A similar number of questions have been received on the helpline. Feedback received from farmers has helped IKSL to

[4] Andhra Pradesh, Tamil Nadu, Kerala, Karnataka, Bihar, Chhattisgarh, Madhya Pradesh, Jharkhand, Uttarakhand, Haryana, Himachal Pradesh, Punjab, Uttar Pradesh, Rajasthan, Gujarat, Maharashtra, West Bengal and Orissa.
[5] A farmer can choose from these local languages: Hindi, Gujarati, Marathi, Tamil, Telugu, Malayalam, Kannada, Bengali, Oriya and Punjabi.

further refine its services. In 2010, mobile-based quiz and phone-in programs have also been introduced.

Table 5. Status of value added services (VAS) of IKSL(in numbers).

Services	July 2007- December 2010	April 2010- December 2010
Voice Messages	1,47,388	37,209
Helpline questions	1,21,496	28,179
Feedback from farmers	5,431	2,933
Phone in programs	354	212
Quizzes	787	457

Source: IKSL presentations and communication with IKSL staff.

A content management system has been developed to support the VAS, supported by content managers posted in different states. A crop calendar and an information calendar for different crops are prepared in which the life cycle of the crop, its different stages, and the information needed in each of these stages are described. These stages are divided into pre-sowing, sowing, flowering, maturity/harvest, post-harvest etc. These stages differ depending on the crop; the stages for wheat, for example, are demonstrated in Table 6. In each of these stages, different information needs are identified and then a mix of messages is determined for each day.

Table 6. Example of a crop calendar for wheat crop.

Crop stage/Crop life (days)/ Information need		
Pre-sowing (-30days)	**Sowing (0)**	**Emergence (0-20days)**
Crop requirement (soil and climate) Soil testing Zero tillage, laser leveling Soil amelioration (S/FYM Varietals selection/ Characteristics Input availability Crop Rotation Soil treatment	Basal application of fertilizers Seed treatment (smut & termite) Seed rate Seeding method/Zero till planting Seed / fertilizer drill	Birds scaring Pesticide application for shoot fly
CRI Stage (20-25 days)	**Tillering (25-45 days)**	**Jointing (45-60 days)**
Termite control First Irrigation Top dressing Urea Application of Zinc sulphate	Herbicide Application Hoeing	Second Irrigation Top dressing Urea
Flag Leaf (60-75 days)	**Flowering Stage (75-85)**	**Milk Stage (85-105 days)**
Third irrigation	Irrigation	Irrigation Rodent Control
Dough (105-120 days)	**Maturity/Harvest (120-135 days)**	**+10-15 Days)**
Irrigation Roughing	Harvesting	Threshing Storage Fumigation Mandi (market) rates/arrivals

Note: Zero sowing date should be adjusted for cultivation situation

Source: Prepared by Dr R.B.L.Bhaskar, IKSL, August 26, 2010.

These messages are a mix of proactive and reactive messages. The proactive messages are predefined, based on the crop calendar, weather conditions, market rates and cropping pattern. The reactive messages are generated based on helpline queries and feedback, which might lead to the development of content that can go out as alerts and warnings. In addition, information on certain events like dates of *kisan melas* (Farmers fair) etc., and various important government announcements relevant for a particular farming group are also delivered. These messages are checked by experts before they are recorded and voice-transmitted.

The development of content is a continuous process, therefore IKSL undertakes in-house surveys as well as surveys by external autonomous bodies to review its functioning constantly, to improve its services and to make it more effective. Assessment of needs is done by experts from time to time, and more prominently in times of abnormal weather conditions. Local partners, NGOs and private companies also partner with IKSL to provide feedback and to share knowledge. The profile of the farmers is captured at the time of initiating the service for them, so that only farmer-specific information is delivered to them.

5.1.3 Partners

In the IKSL venture, IFFCO is the domain expert and Airtel provides the mobile-telephony network for the service. The various content/knowledge partners are State Agricultural Universities, the Department of Agriculture, the Indian Meteorological Department, the Directorate of Marketing and Inspection, Centre for Agriculture and Biosciences International (CABI), the M.S. Swaminathan Research Foundation (MSSRF). NGOs help in mobilizing and creating awareness in farmers of the role played by information in better farming. These NGOs also help in developing the localized content of voice messages that can be understood easily by farmers. The GSMA Foundation (Groupe Spéciale Mobile Association)[6]helps in capacity-building at IKSL and in strengthening infrastructure for quality management and up-scaling of the service-delivery platform.

5.1.4 Results from an independent survey

An independent survey was conducted by a global market research consultant on subscribers across all the states where IKSL is operational. Of the total client base, 25.1% are small farmers. In the sample only 9.5% of the IKSL subscribers were female. Most of the adopters of IKSL services are less than 25 years of age (38.4%) and only 28.8% are above the age of 35 years. Of the total households surveyed, 87.5% earn less than two dollars a day.

Around 30.6% of farmers used friends and other farmers as their main sources of information before they bought the IKSL services; 28.2% depended on co-operative societies like seed co-operatives or PACS (Primary Agricultural Co-operative Societies) etc.; 23.6% depended on

[6] The GSMA represents the interests of mobile phone operators worldwide. It unites nearly 800 of the world's mobile operators, as well as more than 200 companies in the broader mobile ecosystem, including handset makers, software companies, equipment providers, Internet companies, and media and entertainment organizations.

relatives; 8.9% depended on private company representatives and agents; 7.7% depended on advertisements for their information needs. The farmers subscribed to IKSL services for several reasons: 57% of the sample had heard from other farmers that the information was useful, while 27% were influenced by peers who were using the service, and around 15% were planning to buy a new SIM card and thus preferred to buy the IKSL green SIM card.

About 94% of the sample population trusted the information provided by IKSL; 6% of the sample population said that they did not find the IKSL service useful or interesting, or that it did not help them to access new information. About 52.5% of the famers were not using any other source of information except for IKSL, while 32% were still dependent on agricultural information provided by television and radio; a similar percentage relied on the government helpline and 23% had access to extension offices. Seventy-five per cent of users found that information provided by IKSL was more useful than that received from other sources.

An in-house survey done by IKSL shows, that the operations of the focused community for basmati farmers in Haryana appeared to be a win-win situation for all stakeholders. The farmers observed an improvement in the quality and yields of their basmati rice (Figure4). The yields registered an increase of between 16and 25%, together with a decrease in costs incurred on inputs purchased by the farmers. Due to the better quality of rice produced, the overall price that farmers received for their produce was much higher than in the previous year. The Haryana State Co-operative Supply and Market Federation Limited (HAFED)[7]was also able to increase their procurement by 30-35 per cent. In this community, academic and research institutions were the knowledge partners.

Focused community for Basmati Rice in Haryana

- Partner – HaryanaState Cooperative & Marketing Federation (HAFED)
- Implementing Agency - IKSL
- Objectives
  - *Improving quality and yield of basmati rice*
  - *Reducing cost of cultivation*
  - *Increase Income*
  - *Empowering farmers through knowledge input*
- Coverage
  - *Districts covered 4*
  - *Villages 208*
  - *Contract farmers 816*
  - *Area 5970 acres*
- Facilitate better quality and higher quantity of basmati rice procurement by HAFED

Focused community for Women in Tamil Nadu

- Partners : Vidiyal, Common Wealth of Learning
- Location: Theni (Tamil Nadu)
- No. of Women members : 300
- Focused Voice Messages and Helpline on
  - *Goat and Cow Rearing*
  - *Education on Women's Rights*
  - *Other areas of interest (Women's Health)*
- Improved Income levels of members
  - *Loan to create assets - Rs. 11.3 million*
  - *Asset multiplication - Rs. 27.4 million*
  - *Loan repaid in the first year - 30%*
  - *Group increased to 1200*
- Banks willing to finance more women. Group to be extended to 5000
- The women's community received international appreciation

Fig 4: Illustration of Impact of IKSL service

[7]HAFED is the largest Apex Cooperative Federation in the State of Haryana

IKSL believe that its strength lies in its wide accessibility, scalability, reliability and sustainability. The perception of the beneficiaries as per the independent survey was in line with the goals of IKSL.

5.2 RML- SMS based

Reuters Market Light (RML)[8]

5.2.1 Overview

The RML model is not a corporate social responsibility but a business model where the information gap in terms of what a farmer needs and can access is met by an innovative open-source, mobile-based information delivery system, and is an innovation that was conceived by an RML team member at Stanford University in the Reuters Digital Vision innovation program.

5.2.2 Services

RML provides four small text messages (SMS) to registered farmers on universally used handsets. RML's service works across all telecom service providers and mobile phone handsets. These messages for two preferred crops, as indicated by the subscriber, are sent on a pre-paid subscription (Table7). The information is available in eight local languages. These four messages are on crop prices in nearby markets, agricultural news relating to the crop or to input prices, advice to improve yields and the district (50 KM radius) level weather forecast.

Table 7. Details of information delivery service.

Information	No. of SMS per day	Delivery time	Detail
Weather	1-2	Morning (7-9AM)	For tehsil (block) chosen by farmer
Crop Advisory	As applicable	Noon(10:30 – 1PM)	For 2 Crops – as selected
Agriculture News	1	Late evening (6 – 8.30PM)	As relevant to farmers profile and geography
Market Update	1 or 2	As and when the rates come	2 Crops (2X 3 = 6 markets)

[8] From the presentation made by Mr. Amit Mehra, Founder and MD of RML and http://www.indiatogether.org/2010/aug/agr-vidhtech.htm; http://www.medianama.com/2009/04/223-reuters-market-light-goes-to-himachal-pan-india-with-nokia-txt-vs-gprs-vs-voice/

There is a customer care center with a toll-free number that farmers can access if they need further information. All queries are answered in the language preferred by the customer. Customers also have the option to change their crop or market preference at any time during the subscription period. Subscription to the service is simple. All farmers have to do is buy a scratch card from a rural retail outlet and call the RML toll-free number where the subscribing farmer's profile details are collected. Based on the profile of the farmer, the personalized SMS service is activated immediately.

RML covers about 250 crop varieties across more than 1,000 local markets and 3,000 weather locations in India. A well-trained RML team, consisting of several hundred content professionals and agricultural market reporters spread across the length and breadth of the country, source local agricultural information and market prices. This information is validated and processed using best-in-class processes and custom-developed information technology systems to generate highly-relevant, timely and actionable content that can be used by the farmers. RML operates on Reuter's principles of speed, accuracy and freedom from bias.

RML piloted the first trial project in October 2007 in Maharashtra; it spent more than a year pre-testing its services, understanding farmers' needs, and gathering information regarding the perception of SMS-based information services amongst farmers. RML initiated its services in Maharashtra for the charges of Rs 175 for 3 months, Rs 350 for 6 months, and Rs 650 for 1 year. By the end of 2010, a period of less than three years, RML has been able to reach more than 300,000 consumers in more than 15,000 villages across 13 states of India. The benefit of the service is estimated to have been extended to more than a million farmers, taking into account the fact that farmers often share information. The model became self-sustaining after the charges were revised to Rs. 90 for a one-month package, Rs. 250 for a three-month package, Rs 500 for a six-month package and Rs.850 for a one-year plan.

Most of the customers start with a one- or three-month plan and later subscribe to the six-month or one-year package for their selected crops. Customers' preference for half-yearly or annual subscriptions is also an indicator of the acceptance of the service by the farming community. Although the prices charged by RML are viewed as premium prices, the continuous growth in customer base can be seen as an indicator which shows that farmers are willing to pay if they find the information useful.

5.2.3 Model

The business model involves development of content, which is done by hundreds of content professionals in villages and local agricultural markets. Personalized delivery of information is through all telecom operators and over all mobile phone handsets. RML subscription cards are available in thousands of rural retail outlets both through RML's own distribution network and through the network of its channel partners. Marketing activities, including organizing farmers' meets in villages, participation in agriculture fairs etc., are undertaken by the sales and marketing teams of RML to create awareness. Support is provided to the farmer throughout the crop cycle. This has helped create a business model that has activities ranging from content development to distribution of micro-level information that directly impacts the incomes of farmers and farm productivity (Figure 5).

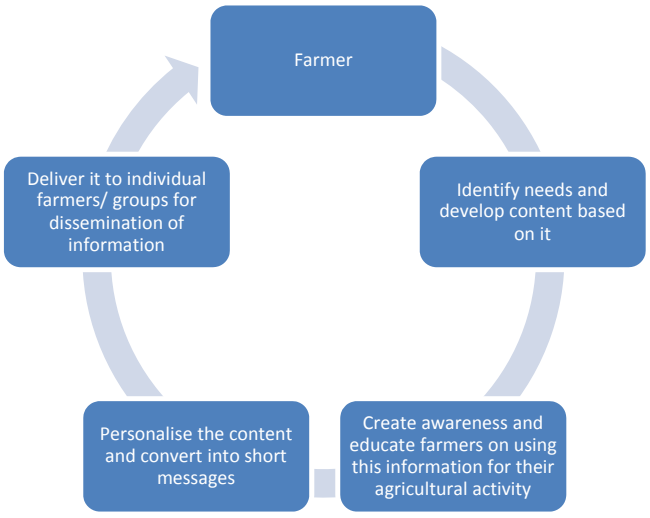

Figure 5: RML operational model

RML's market correspondents observe auctions for different commodities throughout the day to check on prices and market arrivals at the local markets. The information is then sent through their mobiles to the RML system's unique short code. This information is validated using Reuter's best-in-class systems at the state level, to ensure the accuracy and reliability[9] of the information before it is passed to RML's centralized data operations center in Bangalore. The information is analyzed and structured appropriately and then uploaded onto an internal prices application portal, which is checked by the content/quality team for their approval. After this, a personalized SMS message is sent to the farmer concerned according to his commodity and market location preference.

The weather data is sourced from private weather information providers and the Indian Meteorological Department (IMD); for crop information, RML has links with experts of relevant crops and cropping systems in state agricultural universities and various ICAR institutions. For agriculture-related news, sourcing is mainly from the Reuters News Service, RML's own correspondents across states, and the market data team.

5.2.4 Partners

RML has partnerships with various channel partners, including handset manufacturers, telecom operators, banks and agricultural-input companies, to reach farmers. RML also partners with leading agricultural institutes and universities for sourcing and developing agricultural advisory content. In addition, RML works with the Indian Meteorological Department and various other private sector weather information companies to provide local weather information. RML also

[9]RML has a network of experts on their panel. These experts help to validate the content before it is passed on to the farmers.

works closely with various central and state-level government departments and public sector bodies to benefit the maximum number of farming communities in the country.

5.2.5 Impact

RML services have had a major impact on farmers through their commodity price updates and agricultural advisory service. In its initial need assessment, RML found that farmers need information on prices of produce in spot and futures markets, and weather forecasts. This became the main focus area for RML services. In a self-evaluation survey of around 500 farmers by RML, it was found that most farmers felt that they were better informed and could more effectively plan their farming activities; the service helped them to get a better price for their output and to make profits. Ninety-four per cent of the farmers said that they would be happy to recommend RML services to their friends, relatives or fellow farmers.

More than 90% of farmers find that the information delivery through RML SMS is relevant and useful. As expected, the weather forecast and commodity price updates are usually 75-80% accurate but farmers view the commodity news and crop advisory service accuracy at 90%. On average, 80% of the farmers find the information delivered to them reliable. Farmers have been able to make profits by using the different types of messages sent by RML. Forty per cent of the farmers reported that they were able to increase their profits because of the information on weather forecasts, the commodity news and the crop advice they received. But by using the commodity prices updates, about 60%of the farmers using RML services were able to earn profits.

A survey of 580 farmers was conducted by RML to analyze the benefits that farmers get by receiving information through RML. The survey highlighted the fact that 15% of the farmers stated that they could not gain at all from the commodity price updates that RML sends. The rest of the farmers have been able to make profits from price information by analyzing the trends in prices and arrivals and making alternative decisions on selling, storage and target markets.

5.2.6 Key challenges

In the initial stages, the company faced funding problems and start-up challenges in terms of managing people, partners and customers. The key challenge at the time was to develop content according to farmers' needs, and to market that service to the farmer efficiently. As the delivery of information improved, the company realized that although SMS was a better choice than voice messages, there were problems of compatibility with mobile handsets because these were made by different companies, each of which had also introduced several models. This acted as a constraint in scaling up activities. RML is in the process of developing a downloadable application so that this issue can be sorted out. RML is also planning to link up with handset manufacturers in order to find a solution to the problem.

The RML agents sell their service recharge coupons directly to the farmers. This acts as a constraint because most of the poorer farmers are not able to contact these agents at the time of renewal of their subscription and consequently often discontinue using the service. Although RML has a huge network of sales and marketing personnel, problems still arise because addresses

submitted by subscribers are often wrong, making it difficult to reach many of them directly. These issues were not foreseen and steps are being taken to cross this hurdle. To sort out some of these issues, RML is drawing up a strategy to scale up their operations in a sustainable manner. They also plan to expand their operations further to countries in the African continent.

The impact of RML has been observed in terms of increased farm productivity and profitability. The RML model has been able to fill the information gap through a personalized decision-making tool.

5.3 Kisan Sanchar - both voice message and SMS based

5.3.1 Introduction

Kisan Sanchar is an interactive platform for scientists, agricultural experts situated in various universities, KVKs and other agriculture-based organizations for sharing technology and knowledge with registered subscribers in local languages. It is an enterprise-class communication platform to broadcast text and voice messages on the mobile phones of individual farmers. Kisan Sanchar enables companies and organizations to send personalized and interactive outbound text and voice "broadcast" messages at the touch of a button.

5.3.2 Evolution of Kisan Sanchar services

The idea of getting farmers connected to markets through SMS was generated while working with paddy contract farmers and realizing the need to inform them about the daily prices of paddy fixed by HAFED so that they could arrive on time to sell their produce. The SMS was thought to be the cheapest and quickest way to do this. However, problems arose because of low literacy levels and the fact that all mobile handsets were not designed to handle local language messages.

The first service of Kisan Sanchar was launched as a pilot project to deliver price information to paddy farmers (about 250 farmers) in the district of Kurushetra during the 2008 *kharif* season. Later it was continued from May 2009 to November 2009 through the KVK Kurushetra (Haryana), and with the support of Sristi Gyan Kendra. Rather than bulk messaging, Kisan

Sanchar initially preferred to use the SIM[10] card of service providers and an SMS plan, so that farmers could recognize messages sent from a particular number. Later, this system was changed to a computer-based application and an online content-management system.

To ensure that the information made available to farmers could be put to use, training workshops and awareness campaigns were organized before the initiation of the service. Within a fortnight, more than 2,000 farmers had registered for the information service in Kurushetra district alone. The unique feature of the service was that it provided a call-back facility to the service provider through a call center, which was set up in the KVK Kurushetra. By February 2011, the center had received about 7,600 calls asking for greater detail regarding the information sent to them since the service was initiated.

Kisan Sanchar was fully operationalized in August 2010 and service coverage has expanded vastly. At present, it provides services to more than 62,000 farmers across 75 districts in nine states (Haryana, Punjab, Himachal Pradesh, Jammu & Kashmir, Delhi, Rajasthan, Gujarat, Uttarakhand and Uttar Pradesh). These are operating through ten SAUs and their related KVKs.

For scaling up services to meet the expanding client base, it became important to develop a common format to compile information on new subscribers, for content development, and to prepare a schedule to deliver the messages to farmers. These common formats were developed and sent to all KVKs so that they could start uploading the information onto the online portal in a common format.

Kisan Sanchar regularly scans the technical literature published by agricultural universities and research institutes and develops short messages. Crop-wise content is uploaded onto the portal, which is accessible to the users. The content is updated on a daily basis.

5.3.3 Model

There are three levels in the operating mechanism of Kisan Sanchar:

Administrator: The main portal hosting rights are with Kisan Sanchar and messages are transmitted through the administrator.

Collaborators (Content partners): KVKs and NGOs are the collaborators (collaborators fund the project for farmers). They develop the content and post it on the portal through personalized secured access to the content management system. In this system, each collaborator is provided with a unique login identity and password, which enables the user to submit the technological

[10]Villagers often exchange SIM cards and give them to relatives within the family or sometimes even outside the family. This acts as a constraint because in that case the information does not get delivered to the right person.

content to the administrator for broadcasting to the subscribers (the farmers). A working manual has been developed to guide the collaborators; on initiation, practical training is also provided. The list of subscribers is submitted by the user at the time of subscribing to the service. The list can be further amended according to the requirements of the user. The data is fully secured because it is encrypted and cannot be utilized without the administrator's knowledge and permission.

Farmers: farmers receive free of cost text messages and voice messages in their local language.

Other are:

Call Centers: Kisan Sanchar provides a call-center facility to educate farmers by collecting feedback from them, and by referring technical queries to the concerned collaborator to provide the needed information.

Kisan Sanchar volunteers: These conduct surveys in villages, add farmers to the database, and educate them on how they can benefit from Kisan Sanchar.

Upcoming features:

1. Voice messaging on any mobile number in India (without changing the SIM card).
2. RSS (Rich Site Summary)feeds, news on agriculture and allied professions from around 1,500 online publications, including newspapers, magazines and portals;
3. Agricultural statistics and related databases;
4. Online chat among the users; for instance, various KVKs can now interact with each other;
5. Archives of past content and messages.

5.3.4 Impact

In 2007, HAFED was able to procure paddy from only 15 to 20% of its contract farmers. Removing the information gap by launching Kisan Sanchar in 2008 enabled HAFED to procure paddy from 90% of its contract farmers. This ensured that quality produce was delivered to HAFED and better market prices obtained by farmers.

In one of the pilots done jointly by HAFED and IKSL to deliver information to contract farmers of paddy in Kaithal, Karnal and Kurushetra, which was completed in November 2010, an internal study was undertaken to assess the impact of this service on farmers who have used the services and those who have not. The results showed that the reach of this service was more than that of television, radio and newspapers. Various rigorous impact assessments are currently ongoing to understand the impact of this service.

5.3.5 Sustainability of service

At the pilot stage of providing these services, the cost of delivering information to farmers was borne by either Kisan Sanchar or an NGO. However, this was not sustainable over a long period; consequently subscription, based on an estimated cost of delivering an SMS, was introduced. Any institution that wishes to disseminate information to farmers can subscribe to Kisan Sanchar at an annual registration fee of Rs.3,000 and can then deliver the information using the Kisan Sanchar platform.

Overall, this service has helped in bridging the gap between extension workers and farmers, and helped to strengthen public extension services. The aim is to reach more and more farmers across the country, and to deliver the needed information by text and voice messages at low cost to both information providers and farmers in a sustainable manner.

In all three models discussed above, service providers faced certain challenges, but have been able to overcome some of them. Overall, we have learnt the following from these case studies:

1. The information service model should be able to meet the varied and increasing demands of farmers;
2. accuracy and timeliness of service is an important factor;
3. an assessment of the farmer's need for information should be done at the village level, and continuous evaluation of needs should be an inbuilt part of the system;
4. modern service providers should not compete with other service providers but should build synergies with existing extension services and fill existing information gaps;
5. the service providers should utilize the potential of a two-way communication facility on mobile phones, and help lines should be created to provide customized solutions and to enable feedback from farmers; and
6. finally the service providers should have an idea of the existing socio-economic situation of farmers and the prevailing market and infrastructure constraints.

6. Constraints and key researchable issues

The three models highlighted above are some of the relatively successful mobile phone-based information delivery systems. There are several ongoing initiatives (for detailed list see Appendix A1), many of which are on a funded project basis. A survey of existing literature indicates that 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. A strong information network will help small landholders to cope with the risk of climate change in an efficient and effective manner. 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 and researchable issues 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 in areas with a developed infrastructure. Apparently, the poor and those living in distant areas have been excluded. Modern ICT 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 constraints on the use of modern ICT. Although the Mittal et al. (2010) study also found evidence that mobile phones are being used in ways that contribute to productivity improvement, the key message of the study was that the results need to be evaluated in greater depth by conducting impact assessment studies. The study also highlighted the need to establish supporting infrastructure and build farmers' capacity to help realize the full development potential that ICT offers. These include market and institutional credit reforms, better storage and warehousing facilities, and better roads.

The Forum for Agricultural Research in Africa (FARA, 2009) report emphasizes that to monitor the impact of rural mobile telephony on agriculture, a better understanding of the farmer's context for the adoption and adaptation of an innovative information tool is required. 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 said in the context of Africa, but is also true of India (refer to appendix A1).

Based on this, the key researchable issues to further understand the potential of ICT for agricultural development and risk mitigation are listed below. These should be analyzed based on detailed household surveys using rigorous impact-analysis techniques.

Information needs and sources of information for farmers- Detailed household surveys need to be carried out to obtain data on localized existing information-delivery institutions and networks that farmers connect to in order to mitigate their production and market-related risks. What are the existing information gaps? Can modern ICT bridge this gap and what linkages have to be created with other information networks in terms of cost, effectiveness, adaptability, ease of access, timeliness of access and information?

Technology adoption and impact assessment- Can ICT play a role in removing information asymmetry and make the functioning of value chains and markets more efficient? How does market price information benefit the small farmers with limited marketable surplus? Does it help in reducing price disparity and wastage? Does the use of modern ICT reduce search costs and the time lag in technology adoption or its various components? How can we quantify the time saved in terms of value? What experimental techniques should be used to evaluate the impact of these modern ICT-based models? How does one measure the change in a farmer's income or yield that can be attributed to the use of mobile phones? This is a particularly important issue to address since it might prove difficult to filter out the effect of other sources of information that might have a complementary effect. Consequently, establishing causality may prove to be a problem. How does modern ICT impact women and young literate farmers? Does it reduce the existing distress in the farming community?

C***onstraints, policy and sustainability***- What are the constraints that farmers face in utilizing the information they receive through mobile phones? How can they be brought within the ambit of mobile-based information delivery systems or how can the business models evolve to provide solutions? What are the issues in implementing/scaling up modern ICT-based initiatives in agriculture for smallholders? These constraints can be classified into the three broad categories of institutions, infrastructure, and environmental policy. What are the policy solutions to identified constraints and what are the strategic options that would help fill existing information gaps? How can modern ICT models be made sufficiently valuable so that farmers are willing to pay for these services? There will be a need to create a market for information and assign a correct market value to this information for sustainability. What lessons do we learn from the successes and failures of similar models in other parts of the world?

7. Conclusion and summary

Among modern ICT modes, mobile telephony has been the most recent and widely-accepted mode of delivering information not only in India but also in other South Asian and African countries. Increasing mobile phones and mobile phone-based services enhances the availability of knowledge and information and will further help in improving awareness, education, better adoption of technology, better health and efficiency, reduced transaction costs, better market efficiency and better climate-linked risk management. These improvements will in turn catalyze the development and economic growth of the rural sector. In the Indian context, literature on the role of ICT in agricultural growth is documented, but because of the fast-changing scenarios, it has become important to take stock of the literature, to identify research gaps as well as to draw conclusions about the focus areas and the ways in which existing research gaps can be filled.

This scoping study has helped to highlight the various ICT models present in India that are engaged in delivering agricultural information. It has listed the issues that persist in their operation and coverage, and the constraints faced by the service providers. In this scoping study, the literature on the role of mobile phones in improving information delivery has been reviewed. The review has helped to identify research gaps, and has also helped to suggest ideas for further research.

The review of available research shows that information received through mobile phones plays a complementary role to existing extension activities, and has a greater impact than other one-way information sources (e.g. radio, television, newspapers etc.). Mobile-based information services influence the behavior pattern of farmers, and this facilitates the dissemination of information and the adoption of improved techniques, leading to better yields. Information about weather and prices helps farmers to reduce their production and market risks.

The use of modern ICT as a means to precision farming has the potential to improve productivity and contribute to more sustainable production systems. In small-farm agriculture, new tools like yield mapping, remote sensing, leaf testing to time Nitrogen application etc. can help in utilizing the information to improve efficiency (Sudduth, 2007, Islam et al., 2007). The widespread adoption of mobile phones, internet kiosks and village knowledge centers acts as an enabler to precision farming, by educating farmers and improving knowledge-transfer systems. Fischer et.al., (2009), emphasize that ICT has great potential and should be given the same importance as the biotechnology revolution. In the context of India, the impact of mobiles as a way of providing information for farming will depend on how the networks are able to link the farmers to market information in a timely and accurate manner.

The overall goal of using the mobile phone-enabled information-delivery mechanism is to have inclusive growth by reducing the knowledge deficit gap between large and small farmers through creating awareness and imparting information, and also by catering to the specific information needs of different landholders and even of the landless. The expected impact of different types of information is a) an increase in productivity through informed decision making on crop choice, seed varieties, inputs, agronomic practices and plant protection; b) a reduction in production costs

through the adoption of better quality inputs and technologies and better management practices; and c) improved incomes resulting from reduced costs and better price realization for produce.

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. Issues relating to the sustainability of these models still exist. Overtime, as more research is conducted in this area, we will be able to find answers to the questions regarding their usability, potential and sustainability.

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AppendixA1: List of available ICT-based initiatives in India[11]

No	Name	Coverage	ICT type	Initiative Partners	Target group
1	a-AQUA	Maharashtra	Web portal and Mobile	IIT Bombay- Media Lab Asia	Farmers
2	Agmarket	Haryana and North India	Web portal	Ministry of Agriculture, GoI	Farmers
3	Community Radio	All states	Radio	Ministry of Information & Broadcasting, GoI	Farmers and rural people
4	Digital Green	Selected States	Digital Video	Microsoft Research centre	Farmers
5	Drishtee	Selected States	Kiosk	Drishtee Foundation, NGO	Rural people
6	E krishi- e agriculture	All India	Web portal	NAIP	Farmers
7	E sagu	Andhra Pradesh	Internet, Telephone and Kiosks	Collaboration between different agencies	Farmers
8	E-chaupal	Selected States	Internet Kiosk	ITC- Private company	Farmers
9	Fisher Friend	Tamil Nadu and other coastal areas	Mobile phone with inbuilt software	MSSRF-Qualcom	Fishermen
10	IKSL	All India	Mobile based green sim card specific voice message	IFFCO- Airtel (cooperative and Private together)	Farmer
11	Agriwatch Portal	India	Web portal	Indian agribusiness systems limited	Farmers, traders and other players of the value chain
12	Kisan Call Center	All India	Phone based help line	Government of India	Farmers
13	Kisan Sanchar	North India	Mobile phones- SMS and Voice message	Private initiative in collaboration with KVKs	Farmers
14	Kissan Kerala	Kerala	Web portal, video and SMS	Department of Agriculture, Govt. of Kerala	Farmers
15	Mandibhav	All India	Mobile based price information	BSNL, Tata Teleservices and developer Impetus Technologies	Framers and Traders
16	M krishi	All India	Mobile based application	TCS	Farmers
17	Nokia Life Tool	Selected Nokia phone holders	Mobile application	Nokia	Farmers
18	RML	13 states	Mobile based SMS	Private- Thomson Reuters	Farmer
19	Tata Kisan Sanchar	All India	Information on SMS and delivery of inputs	Tata chemicals limited	Farmers
20	Village Resource Centers	Tamil Nadu	Internet Kiosk	MSSRF	All villagers
21	Warna Unwired	Maharashtra	Mobile phone	Warna Sugarcane cooperative and Microsoft research centre	Sugarcane farmers

Source: Compiled from individual websites, NAIP, NIRD and other online sources

[11] There are several such initiatives; only the ones that have wide coverage area are listed here. This is not the complete list.