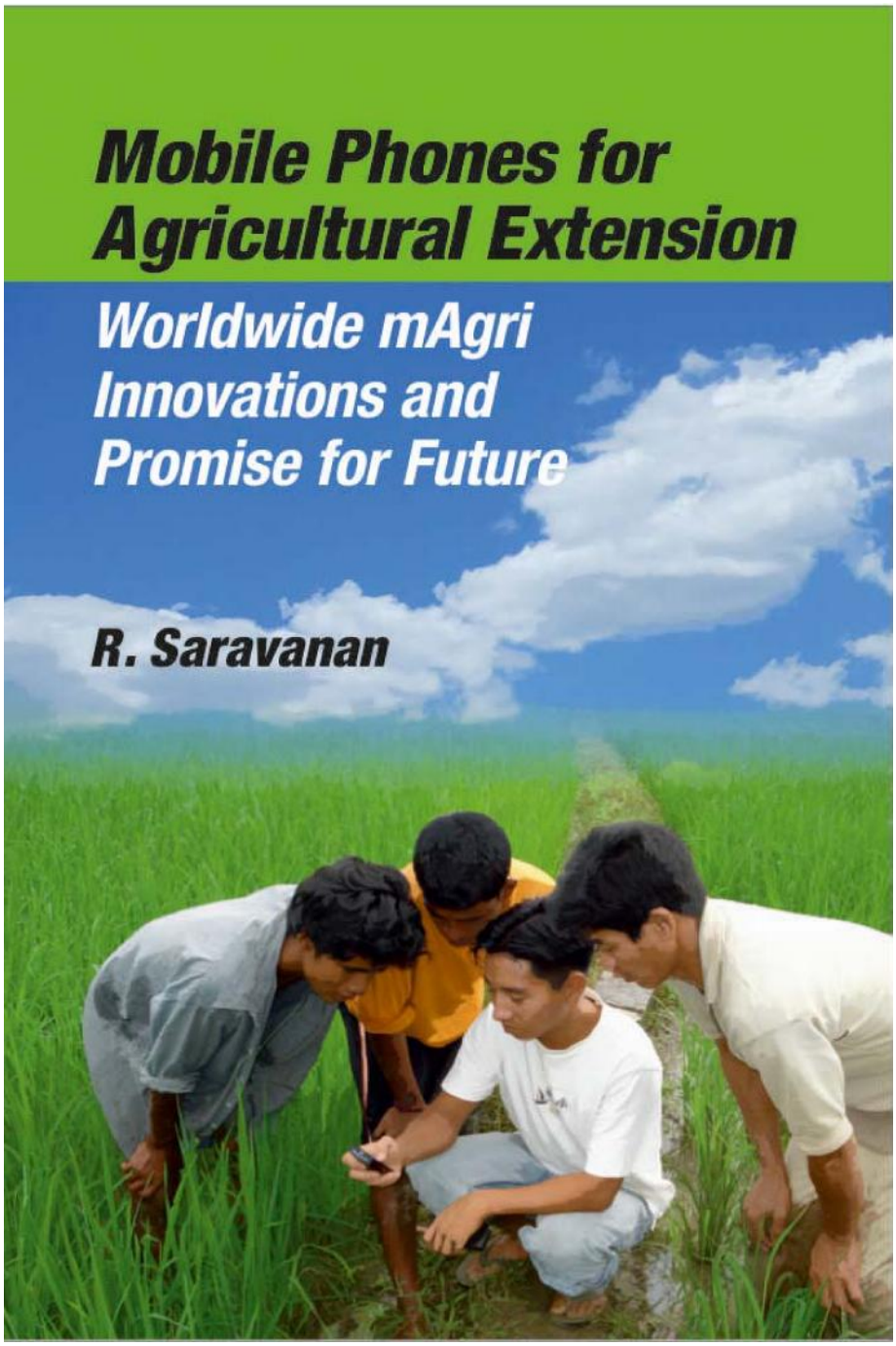


Reference:

Saravanan, R., and Suchiradipta Bhattacharjee, (2014). Mobile Phone Applications for Agricultural Extension in India, In: Saravanan, R (Ed.). ***Mobile Phones for Agricultural Extension: Worldwide mAgri Innovations and Promise for Future***, New India Publishing Agency, New Delhi. pp. 1-75

1

Mobile Phone Applications for Agricultural Extension in India

Saravanan, R., and Suchiradipta Bhattacharjee

Contents

Abstract

Agriculture continues to be the most important sector of the Indian economy and agriculture is a more or less a compulsion for livelihood of millions of farmers. Land and water resources have almost reached their limits, price of commodities are fluctuating almost every day, profits are negligible for most of the marginal and small farmers and most of all getting information is cumbersome. In present day agriculture, soft resources like knowledge and skills are as important as hard resources like inputs, and sometimes more important. But estimates indicate that 60 per cent of farmers do not access any source of information for advanced agricultural technologies resulting in huge adoption gap. The requirement of field level extension personnel is estimated to be about 1.3 -1.5 million against the present availability of about 0.1 million personnel. The mobile phone comes into the picture here. In today's world, almost everybody owns a mobile phone. This huge reach, if harnessed in agricultural extension, can change the face of agriculture altogether in a developing country like India where we have nothing to lose by using it as a medium to disseminate agricultural information in multimodal form. Many initiatives have been taken in this regard to utilize mobile phones by private sector **(**Indian Farmers Fertilizer Cooperative Limited, Nokia, Airtel, Tata Consultancy Services, *etc*.) and public sector (Ministry of Agriculture, Universities like Tamil Nadu Agricultural University**,** research institutions like Indian Council of Agricultural Research, State Governments of Haryana and Kerala, Indian Meteorological Department and others) in agricultural advisory service for agronomic practices, weather forecasts and market price . With increased dependency, the mobile phone is becoming a common communication platform of the world, especially for agriculture.

1. Introduction

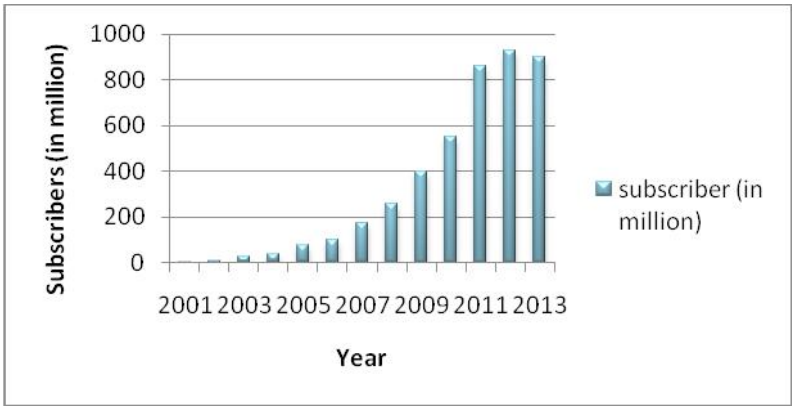
Agriculture continues to be the most important sector of the Indian economy. Research, extension and farmers' efforts have all contributed significantly in increasing food production from 50 million tonnes in 1950-51 to a land mark achievement of an estimated 259.32 million tonnes in 2011-12 (MoA, GoI, 2013). The total demand for food grains is projected to touch 280 million tonnes by the year 2020-21. Meeting his demand will necessitate a growth rate of nearly two

per cent per annum in food grain production (Singh, 2011) and the agriculture sector needs to grow at a targeted four per cent per annum. Approach paper of the India's 12th five year plan (2012-17) states that the "weakness in the economic performance thus far is that growth in the farm sector" (PC, GoI, 2011) and the average of annual growth rates of GDP in agriculture and allied sectors during the eleventh plan period (2007-12) was 3.3 (PC, GoI, 2013). Hence, there is an immediate need of vibrant, dynamic and innovative approach to be adopted for agricultural extension in order to achieve targeted growth rate and serve the farmers better. Further, land and water resources are almost reaching their limits; hence, achieving food security heavily relies on "Knowledge Resource" (Saravanan, 2011). Estimates indicated that 60 per cent of farmers do not access any source of information for advanced agricultural technologies resulting in huge adoption gap (NSSO, 2005). In India, there are about 120 million farm holdings and the number is growing year by year. To provide at least one village extension personnel to 800-1000 farm families, the requirement of field level extension personnel is estimated to be about 1.3 to 1.5 million, against the present availability which is only about 0.1million (100 000) personnel (PC, GoI, 2007). According to estimates, on an average a public extension personnel spends 40 minutes per year for a farmer (Dileepkumar, 2012). With this kind of contact intensity, a complementary service is a non-negotiable need of the country's farmers. In this existing scenario, it is expected that the integration of ICTs in agricultural extension will provide much needed impetus to agricultural sector and ICTs can complement the traditional extension system for "Knowledge Resource" delivery to the millions of the farmers (Saravanan, 2010). Among ICTs, impressive penetration of mobile phones in many of the developing countries changing the agricultural communication process and mobile phones have made personal communications readily accessible, for the first time, to women and men, poor and prosperous, rural and urban dwellers in developing as well as in industrial countries (Colle, 2010).

2. National Telephony and Mobile Infrastructure Scenario

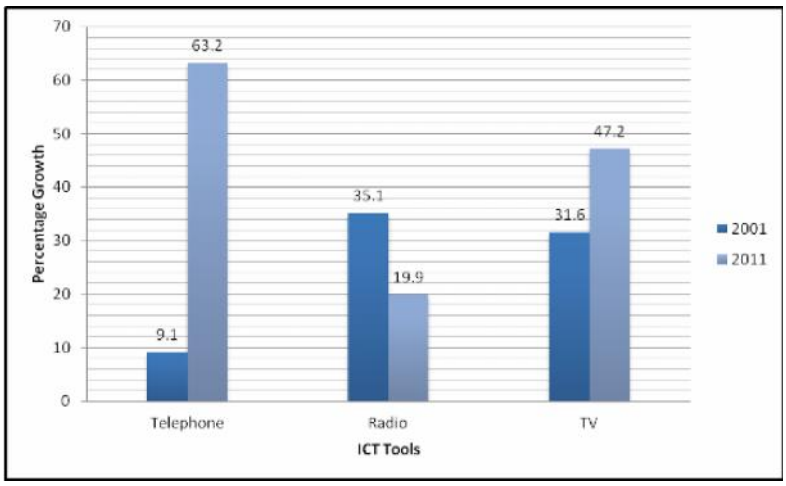
Strategic reforms in telecommunications sector since 1990's have facilitated strong ICT infrastructure in India. As on May, 2013, the number of telephone subscribers was 900.05 million (870.20 million wireless and 29.85 million fixed land line telephones) and 15.05 million broadband subscribers were estimated by the Telecom Regulatory Authority of India (TRAI, 2013). The tele-density has reached 73.33 as of May, 2013 (number of telephone subscribers per 100 individuals). However, there is huge gap between urban and rural tele-density, 145.54 and 41.60, respectively. Despite several policy initiatives to promote rural ICT penetration, growth in tele-density continues to be skewed in favour

of urban India. Total internet users are 164.81 million (12.97 per cent of population) as per TRAI (TRAI, 2013). In India, there are 15.13 million broadband subscribers as on March, 2013 (TRAI, 2013). The growth of mobile phones in the country has been phenomenal during the last one decade (Fig. 1). It has surpassed the growth of other popular ICT tools like TV and radio in the last decade though it is the latest addition to the list (Fig. 2).



*2013 figures are upto May, 2013
(Telecominfo, 2009; Wikipedia, 2012; TRAI, 2013)

Fig.1: Growth of Mobile Phone Subscribers in India



(Census of India, 2011)

Fig. 2: Comparative Growth of Telephone, Radio and TV in the Last Decade

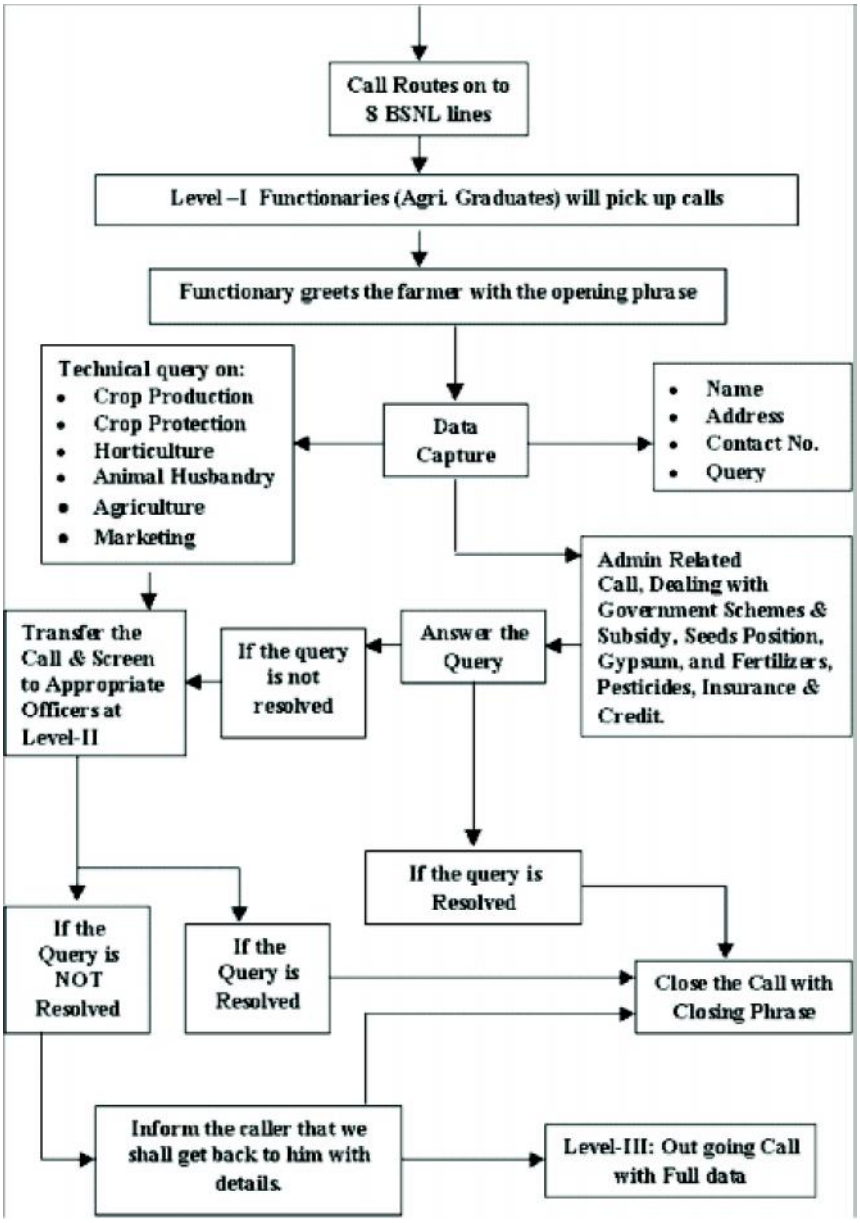
3. Review on Mobile Applications for Agricultural Extension

3.1. Mobile Advisory Services by the Public Sector

3.1.1. Farmer Call Centre (Kissan Call Centre)

The Department of Agriculture & Cooperation (DoA&C), Ministry of Agriculture, Govt. of India launched Farmer Call Centres across the country on January 21, 2004, to deliver extension services to the farming community. The purpose of these call centres is to respond to issues raised by farmers, instantly, in the local language. There are call centres for every state which are expected to handle traffic from any part of the country. Queries related to agriculture and allied sectors are being addressed through these call centres. The Farmer Call Centre is a synthesis of two hitherto separate technologies namely, the Information and Communication Technology (ICT) and the Agricultural Technology- both have their specialized domains and work cultures. To optimally utilize the strengths of both these systems, it was proposed to take full advantage of professionally managed Call Centre mechanism and dovetail it with the specialized Subject Matter Specialists knowledge of Agricultural Scientists and Extension Officers, so as to facilitate its reach to the farming community. It was accordingly proposed to make use of existing specialized infrastructure of Call Centres (which are normally industry-driven and serve to high-end and many a times, mission critical service sector) and make this communication backbone available to the Subject Matter Specialists of Agriculture, Horticulture, Animal Husbandry, Marketing and other related areas. The Farmer Call Centre consists of three levels – namely Level-I (the basic Call Centre interface, with high quality bandwidth and local language proficient Agriculture Graduate), Level-II (Subject Matter Specialists on concerned important crops and enterprises, connected through good bandwidth telecom and computer connectivity) and Level-III (the Management Group to ensure ultimate answering and resolution of all the farmers' queries which are not resolved at Level-II, connected on and off line mode).

Farmer Dial Help Line



(http://www.manage.gov.in/kisan/Operational_mechanism.htm)

Fig. 3: Schematic Representation of Farmers Call Centre Operational Mechanism

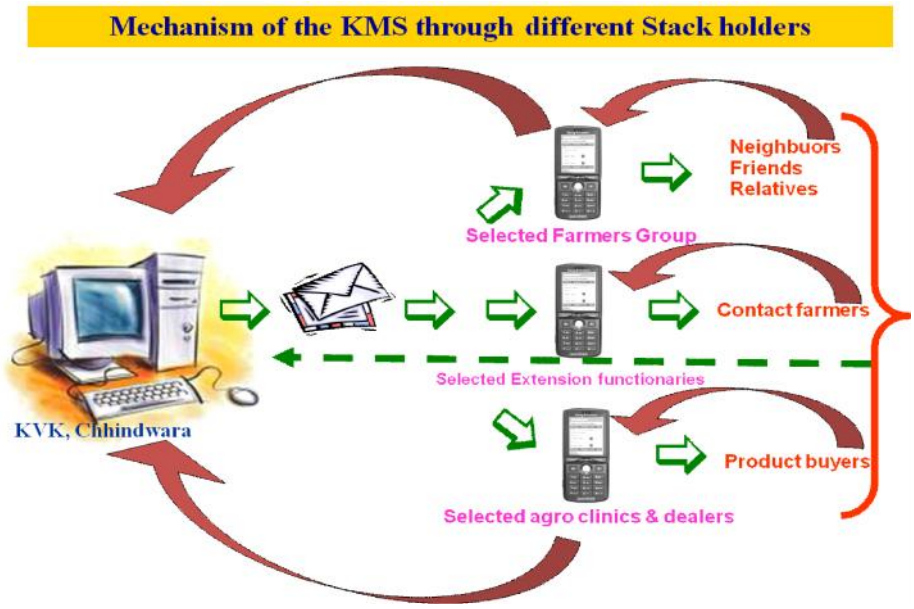
An evaluation study by Hanumankar (2011) asserts that there is considerable interest and acceptance among farmers for ICT based agricultural extension services. The study has shown that farmers in the age group of 29 to 48 years are the biggest user group of KCC helpline. In terms of academic background, farmers with a minimum exposure of six to seven years to formal schooling (86%) seek to utilize the KCC support and relatively inexperienced farmers with less than 10 years of experience are more likely (47.5%) to call the KCC. The scope to enhance awareness and access among women farmers to the KCC helpline is huge as their current levels of participation are negligible. As regards the performance of KCCs, 84% of the farmers who called the KCCs expressed overall satisfaction from the advice provided through the helpline. Of all the supply side factors like promptness of response, patient hearing and completeness of answer, farmers who received a complete response are 47% more satisfied than those who did not receive a complete response. There is also evidence of farmers' satisfaction growing with repeat calls made by them to the KCCs. Analysis of satisfied farmers by the demographic profile suggests that younger farmers below 38 years of age with post matriculate academic background, and less than 10 years' of farming experience expressed the highest levels of satisfaction. Where the farmers were dissatisfied the common reasons were found to be the impracticality of advice provided by KCC agents at level -1 due to their obsolete knowledge and inability to comprehend local accents and dialects. Delayed access to Level - 2 experts was also found to be an irritant by the farmers. As regards the reasons for farmers not calling the KCCs, the study unambiguously established that nothing short of a professionally planned and promoted publicity blitz can crack the lack of awareness about KCCs among the farming community. There is also a need to review issues of telecom connectivity particularly in remote and far-flung villages.

IFFCO Kisan Sanchar Limited (IKSL) joined hands with the Ministry of Agriculture in 2012 for a total revamp of the infrastructure of KCCs at identified locations (Tiwari, 2012).

3.1.2. Mobile Advisory Services by ICAR-KVKs

Mobile advisory services to the farmers by the Farm Science Centres (KVKs) of the Indian Council of Agricultural Research (ICAR) have been operational since, 2008. The Farm Science Centre (Krishi Viigyan Kendra -KVK), Babhaleshwar, India has pioneered in the IT-enabled service aiding instant messaging from Farm Science Centre to individual farmers for extending Agricultural information through SMS alerts. Weekly SMS alerts are issued on various agricultural developments like weather forecast, disease forecast and market information (http://www.kvk.pravara.com). KVK, Chhindwara, Madya

Pradesh implemented a programme called "Kisan Mobile Sandesh" for giving bulk SMS to the farmers. From the year 2010 onwards large numbers of ICAR-KVKs have been disseminating farm information by Kisan Mobile Advisory Services (KMAS). For example, annual report of the KVK- Zonal Project Directorate –VIII, Bangalore during the year 2009-10 reports that 6765 SMS were sent benefitting 34844 farmers. Out of which maximum SMSs sent by KVKs in Karnataka (5192) followed by Tamil Nadu (1022) and Kerala (551), thereby covering 21752, 8499 and 4593 farmers, respectively (Annual Report, ZPD-VIII, 2009-10).The facility had mixed responses from the farmers as there are inherent limitations of the KVKs to provide better service. KVK, South Tripura has 254 farmers registered under the service till March, 2013 and had sent 98 messages to the farmers in the year 2012-13 (Annual Report, KVK South Tripura, 2013). KVK of Rajmata Vijayaraje Scindia Krishi Viswa Vidyalaya, Gwalior has 1000 beneficiaries enrolled under its Kisan Mobile Sandesh including farmers, extension functionaries and officials of line departments (KVK, RVSKVV, 2012). Impact of these mobile based advisory services on farmers and their income are yet to be conducted.



(Abhay Wankhade *et al*., 2011)

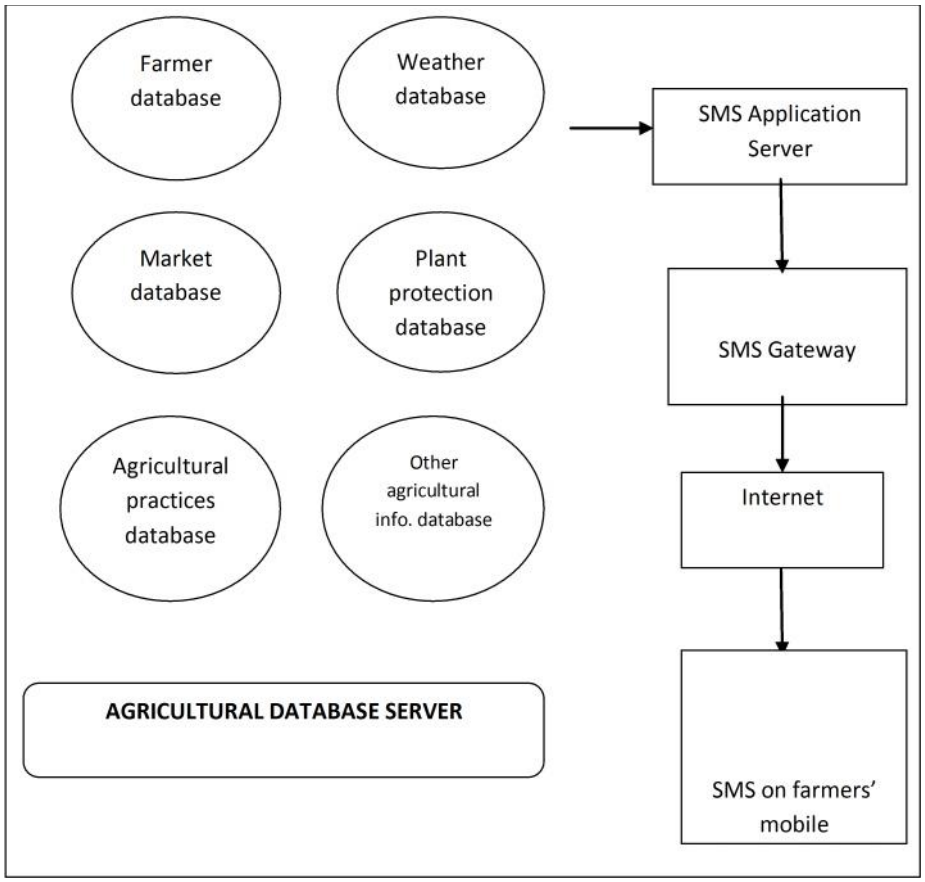
Fig. 4: Mechanism of the Kisan Mobile Sandesh (KMS) through Different Stakeholders (KVK, Chhindwara, Madya Pradesh)

In the study conducted to understand the utility of the mobile based agro-advisory services in an underprivileged area like the state of Meghalaya in North-East India, it was found that the response in terms of satisfactory level with the service and its utility was not very encouraging. However, the approach of farmers towards mobile phones in farming was very enthusiastic. This is heartening considering the fact that even though 50% of the respondents owned a TV and 65% a radio in their household, all of them had mobile phones. Interestingly, 17.5% of the respondents were functionally illiterate, but took the help of other family members to read the messages they received. But due to lack of proper awareness initiatives from the KVK, many farmers did not have a clue from whom they are receiving the messages and those who wanted to access or subscribe it did not know whom to contact. As of now, 65% of the farmers are not satisfied with the service, but the scope to improve is immense, if timeliness, content of the message and personalization of the message is taken care of (Suchiradipta, 2012).

3.1.3. SMS Broadcast Service by KVK, Babhaleshwar

The Farm Science Centre (Krishi Viigyan Kendra -KVK), Babhaleshwar, India has pioneered in the IT-enabled service aiding instant messaging from Farm Science Centre to individual farmers for extending Agricultural information through SMS alerts in the year 2006. The service comprises sending Short Message Service alerts on cellular phones registered at Farm Science Centres by individual farmers. Weekly SMS alerts are issued on various agricultural developments like weather forecast, disease forecast and market information. The service is also being used as a medium to send information on important trainings and other programmes to the members of the Farmers Clubs and SHG network under the Farm Science Centre. The service is an important milestone in reaching out to millions of farmers at a stroke of a mouse click, and enables the farmer to have information access and derive the fruits of technological prowess and face the challenge of an upcoming free market. The service is a boon for hundreds and thousands of farmers around the Farm Science Centre within Ahmednagar District. There are currently 284 registered farmers availing this service from the Farm Science Centre, Babhaleshwar. All registered farmers who are having cellular mobile handsets supporting all major GSM/CDMA networks compatible for Devnagari Unicode fonts within the country can receive the SMSs from Farm Science Centre without incurring any cost. The Farm Science Centre bears all costs of sending the SMS to all the registered farmers having cell phones. In continuation with the efforts of the Farm Science Centre in dissemination of agriculture technological information, the Farm Science Centre have further started the Marathi based SMS text delivery for the cellular handsets users within the District. The vernacular

delivery module was commissioned during 2008. The service has been well appreciated by the farmers who have said such a service by the Farm Science Centre is just in the nick of time when farmers have their crops ready for market. The number of farmers coming to the Farm Science Centre is growing day by day and the Farm Science Centre expects to add another couple of hundred farmers by every year (http://www.kvk.pravara.com).



(Bhaskar, 2013)

Fig. 5: Architecture of SMS Application

In an impact study of the SMS service of Farm Science Centre, Babhaleshwar by Bhaskar (2013), 70 per cent of the people contacted said the service was excellent and the rest 30 per cent said it was very good. The farmers reportedly received 25-30 messages per month at a nominal charge of Rs. 100 (USD 1.7) per year. Moreover they said that if every alert is free, the usability of the alert service is not effective.

3.1.4. Mandi on Mobile Service by BSNL

Uttar Pradesh State farmers are able to know rates of agriculture commodities in any market in the State on their mobile phones, service was launched by the State-run telecom major Bharat Sanchar Nigam Ltd (BSNL) teamed up with the Uttar Pradesh Agricultural Marketing Board (Mandi Parishad) to launch the 'Mandi on Mobile' service for the farmers (Manoranjan, 2009). The service would be voice-based. To know the rates of over 100 commodities including crops, vegetables and other items, the farmers need to dial a specific number from their BSNL cellular phones, and follow the voice command subsequently. The service would immensely benefit the farmers, especially those who used to sell their agriculture produce to middlemen at low prices without knowing the market rates (IANS, 2008). Second phase on "Digital Mandi" was launched by the BSNL in collaboration with IIT, Kanpur, in August, 2011. The "Digital Mandi" application is for effective dissemination of mandi (market) rates of different crops, in approximately 3 000 agricultural produce markets to the Indian farmers.

(Hedge, Unknown)

Fig. 6: Architecture of Mandi on Mobile which Supports Multi Modal Query and Retrieval to Help the Literate and Illiterate Farmers

3.1.5. Market Price by SMS by Rubber Board, India

The Rubber Board provides the update of both national and international rates of natural rubber through SMS throughout the country. Through this service the rubber farmers and dealers in India (especially those in the state of Kerala in South India) are tracking the prices of the commodity in real time by SMS. The rubber growers are helped by this SMS service by the Rubber Board which provide updates on the global as well as domestic market rates to the farmers, which is also displayed in the Rubber Board's web portal (www.rubberboard.org.in).

3.1.6. SMS Service to Farmers by the Department of Agriculture, Haryana State, India

Farmers of Chandigarh (India) are using mobile phones to sort out agricultural related problems. The Haryana Agriculture Department has introduced Short Messaging Service (SMS) for farmers. The service was made available by the agriculture department's Kissan (Farmer) Call Centre. More than 800 farmers had sent their queries through SMS service and replies had been sent by concerned officials and agricultural scientists. The free of cost SMS service is available to farmers on providing one's mobile number (News-i4d, 2007).

3.1.7. Dynamic Market Information (DMI), TNAU-C-DAC, Hyderabad

The Tamil Nadu Agricultural University (TNAU) and Centre for Development of Advanced Computing (C-DAC), Hyderabad jointly provided daily market information on 161 perishable commodities from 13 markets in South India where information was disseminated to ten thousand farmers through mobile based SMS in the local language at free of cost. The information was also uploaded in the web portals of India development gateway (InDG) and Tamil Nadu Agritech portal (www.indg.in & http://agritech.tnau.ac.in). Further, it also provides price behaviour and market trends over a period of time (Anandaraja *et al.*, 2011).

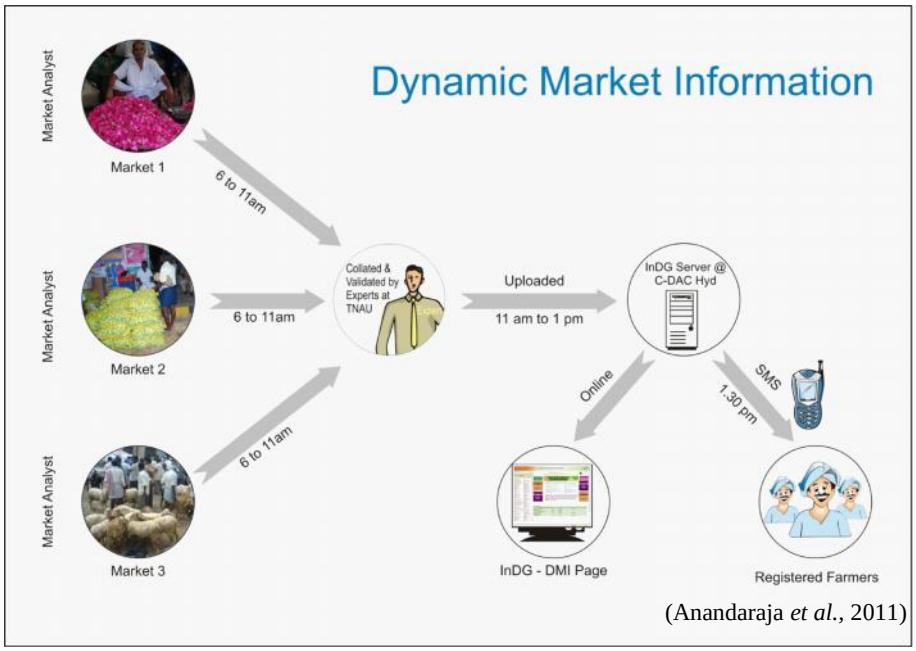
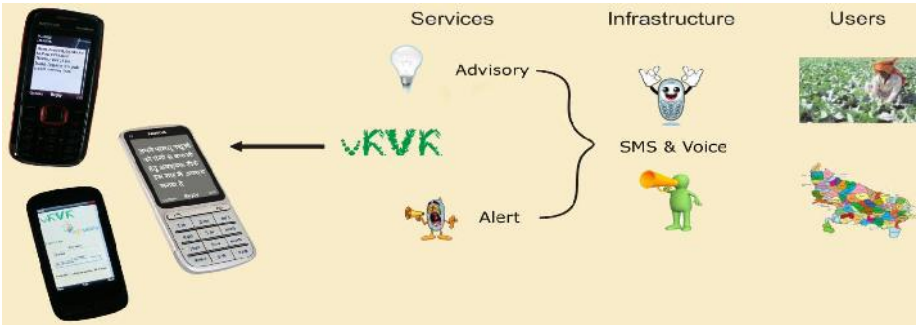


Fig. 7: Schematic Diagram of Dynamic Market Information

3.1.8. vKVK (Virtual Krishi Vigyan Kendra)

vKVK (Virtual Krishi Vigyan Kendra), a simple messaging system based platform allows Agro-advisories to be sent to the farmers' cell phone using SMS alerts and voice-based advisory. vKVK is a platform that connects KVKs with farmers through internet and mobile technology. A phone-based delivery system allows an agricultural expert to transmit a voice-based alert/advisory to be transmitted to farmers through a phone call. A recorded message can be transmitted *via* vKVK platform to all farmers under the guidance of KVK experts. This platform is currently being tested in some selected districts of Uttar Pradesh, Uttarakhand and Karnataka (ICRISAT, 2012).

.

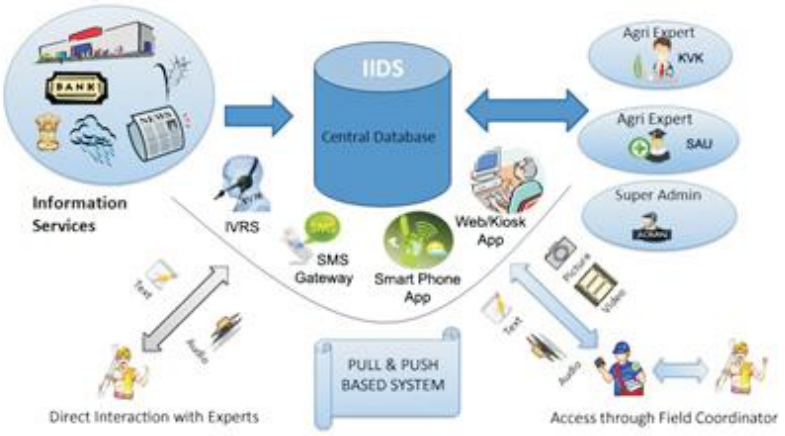


(ICRISAT, 2012)

Fig. 8 : Schematic Diagram of Virtual Krishi Vigyan Kendra (vKVK)

3.1.9. Interactive Information Dissemination System (IIDS)

IIDS is an outcome of a comprehensive need assessment study carried under the component 4 of National Agricultural Innovation Project (NAIP), Indian Council of Agricultural Research (ICAR) project. A total of 26 ICT initiatives in agriculture were studied covering 1381 farmers in 57 selected sample villages across 12 states of India to elicit the need of the farmers, prioritize their perceptions, and bring out the reality of the issues involved in development of ideal ICT based applications for agriculture. Apart from the field study of farmers and ICT initiatives, a series of regional and national workshops were organized with different stakeholders including agriculture domain experts, technologists, private industries, NGOs and progressive farmers (Anurag and Shambhukumar, 2012; Media Lab Asia, 2013) to find out an appropriate ICT model to cater the needs of the Indian farmers. Based on the research findings and analysis of existing ICT initiatives, the IIDS framework was developed. The IIDS framework is currently being pilot-tested in Andhra Pradesh as Annapurna Krishi Prasaar Seva and in North-East India as m4agriNEI.



(Media Lab Asia, 2013 & m4agriNEI Project Folder, 2013)

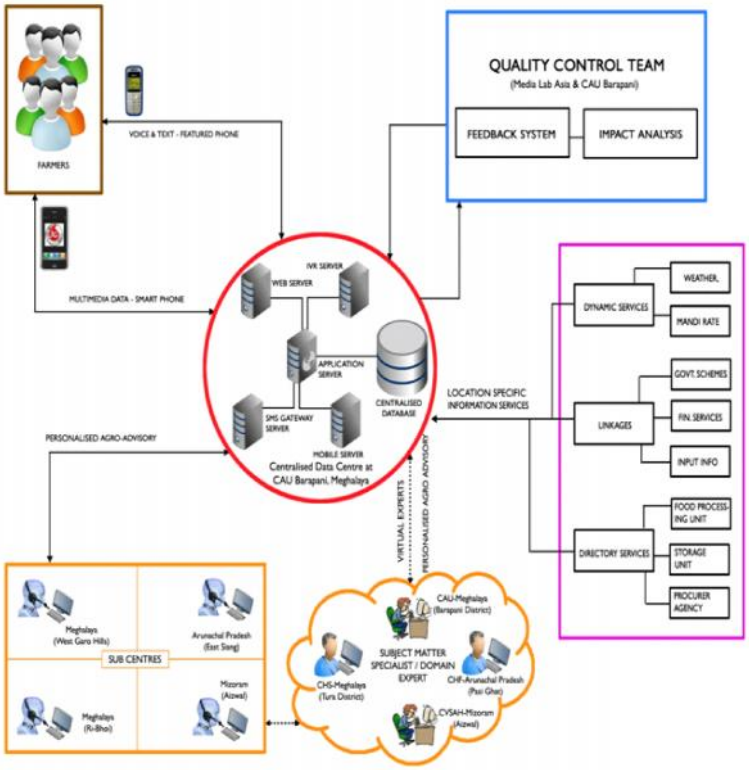
Fig. 9: Integrated Information Dissemination System (IIDS) Framework

Annapurna Krishi Prasaar Seva: Annapurna Krishi Prasaar Seva is being pilot-tested with 600 farmers from six villages of two districts of Andhra Pradesh by the Media Lab Asia (Department of Electronics and Information Technology (DeitY), Ministry of Communications & Information Technology, GoI and Acharya N G Ranga Agricultural University through its KVKs namely KVK - Nalgonda and KVK – Nellore. Personalized agro-advisory on agriculture (paddy), animal husbandry (dairy) and fisheries, local market price of important crops, weather based advisory, crop calendar based services, special message services are being provided to the farmers under this project (Media Lab Asia, 2013).

3.1.10. Mobile based Agro-Advisory System in North-East India (m4agriNEI)

m4agriNEI is a mobile based pull and push based system where agriculture related information can be pulled by the farmers and pushed by the advisory service providers using their mobile phones. There would be a mobile interface at the front end for the farmers and web interface at the back end for the agricultural experts. The system allows transmitting data through voice, text, images and videos from both ends (farmers to expert and back). Furthermore, a farmer can call the system to get any information as well as to get agro-advisory. This system will provide options to farmers to subscribe to the various information services. A farmer will receive information (SMS/ voice call/ data on smart phone) for only those services for which she/he has subscribed to and has an option at a later date to either select some more services, or unsubscribe to some of the existing services. The system will be connected to a centralized

database, which should have all the information on farms, farmers and previous transactions. The experts at back end (data centre and virtual expert) can access the database of the farmers while responding the farmer's queries. The major component of the proposed m4agriNEI system is as follows: Personalised Agro-Advisory by having an advisory lab (Query Processing Lab) with the components such as web-based virtual lab, virtual experts, and web-based Expert Support System (ESS) software. Further, information aggregation and dissemination system has been established with the Quality Control Team (QCT). The salient features of m4agriNEI system are IVRS, smart phone application, web application, expert support system, and centralized database. The m4agriNEI project was initiated since June, 2012, in the four districts of Meghalaya, North-East India. The m4agriNEI is being implemented by Central Agricultural University (CAU) and Media Lab Asia. The project experiments with the smart phone based agro-advisory system (m4agriNEI project folder, 2013).



(*Source*: Medial LLab Asia- CAU- m4agriNEI Project Proposal Document, 2012)
Fig. 10: Working Architecture of m4agriNEI

3.1.11. mKisan

The mKisan project has been launched with the support of mFarmer initiative challenge fund. The International Livestock Research Institute (ILRI), India is implementing the mKisan project in partnership with Handygo technologies, a mobile value adding service provider, CABI South Asia, and Digital Green, an NGO for video enabled extension. The project proposes to develop a comprehensive agro-advisory services for small holders with access to a mobile phone in India. The project has objectives such as to provide daily bulletins on agro-meteorology, crop pest and livestock diseases outbreaks, market information, and information on local service provision sources and information access to women farmers. The CABI will be providing scientifically validated and actionable information from its "Direct2Farm Repository". mKisan project aims to reach-out one million small holder farmers in the states of Utter Pradesh, Bihar, Madhya Pradesh, Maharashtra, Andhra Pradesh and Karnataka in India, over a 24 month period (ILRI project profile, 2012).

3.1.12. AGMET Services by IMD

India Meteorological Department (IMD) delivers Agro-meteorology services to farmers by public-private partnership with the mobile service providers such as Reuters Market Light (RML), Handygo, IFFCO Kisan Sanchar Limited (IKSL), Nokia Life Tools and State Govt. of Maharashtra.

3.1.13. Intelligent Advisory System for Farmers (IASF)

In the states of Manipur and Meghalaya, India, IASF is currently catering to the needs of 1886 registered farmers in six districts of Meghalaya and nine districts of Manipur which uses the platform to redress of their farm related problems. Fifty Subject Matter Specialists are also registered in the portal to respond to farmers' queries.

The project is funded by the Department of Information and Technology, Government of India, and was launched in collaboration with the Centre for Development of Advanced Computing (CDAC), Mumbai, the Department of Agriculture, Government of Meghalaya, Farm Science Centres (Krishi Vigyan Kendras) of Meghalaya, the Department of Agriculture, Government of Manipur and Central Agricultural University, Imphal. The farmers' queries related to Insect Management, Disease Management, Weed Management, Rice Variety Selection and Fertilizer Management along with their solutions (by an agriculture expert from his/her registered mobile phone *via* SMS to 51969) are stored in a database, thus forming a large database which the farmers can access anytime in case of contingencies (IASF, 2013).

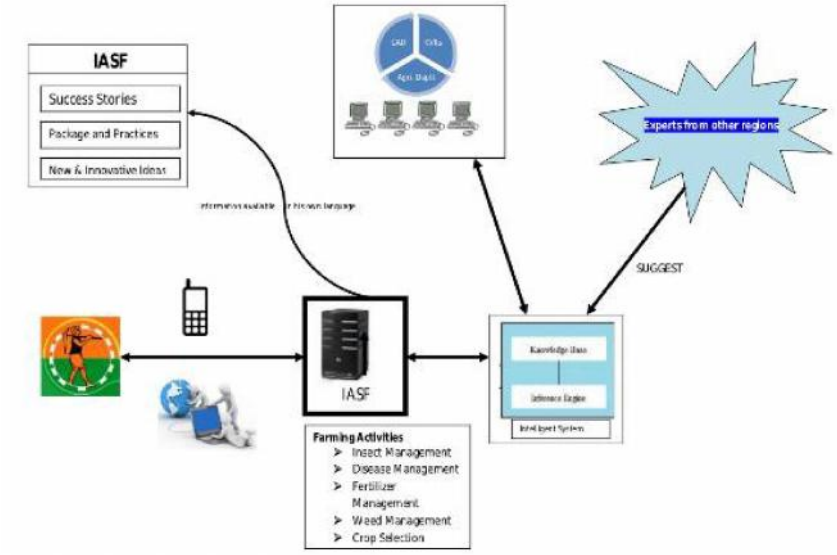


Fig. 11: Working Structure of IASF (www.iasf.cdacmumbai.in, 2013)

3.1.14. Kissan Kerala

It is a multi-modal agricultural information system for farmers of Kerala by the Department of Agriculture, Government of Kerala, in collaboration with Indian Institute of Information Technology and Management – Kerala (IIITM-K). The Kissan mobile-based advisory services provides the farmers with up-to-date agricultural information through SMS based service (both push and pull), voice-based agro-advisory service and videos in the local language. The farmers can register to the service either by sending SMS or can register online (www.kissankerala.net, 2013).

3.1.15. Kisan Help Line

Since 2012, Bihar Agricultural University, Sabour, has started a help line for the farmers of the region. The farmers can call on the helpline number 0641-2451035 and ask their queries to the agricultural scientists from different streams. The helpline works from 10 a.m to 5 p.m on all working days.

3.2. Mobile Advisory Services by the Private Sector

3.2.1. Lifelines India

Connectivity by innovative mix of internet and telephony reaches 200 000 farmers in 2130 villages in four states of India (www.lifelines-india.net) with more than 400,000 questions and answers in their knowledge base and eight completed

crop cycles. It operates in partnership mode with other organisations and NGOs.

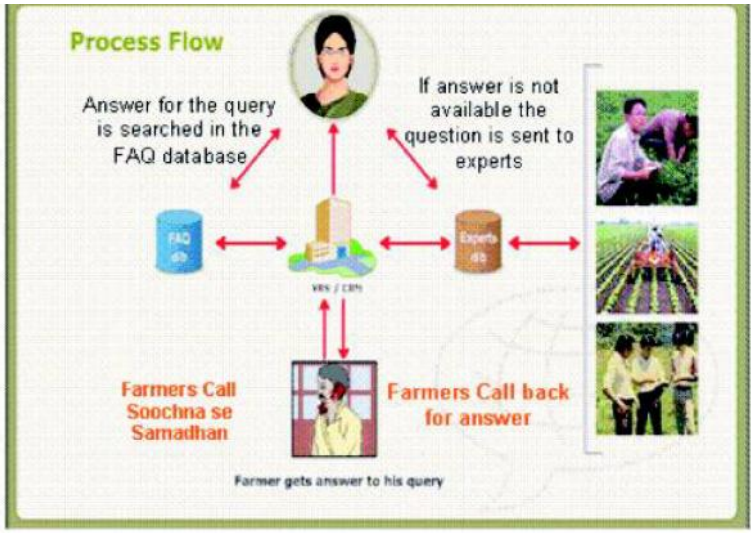
Lifelines India- Soochna Se Samadhan (Solutions through Information), is an initiative to use the power of voice as the primary means of information dissemination**.** It facilitates the exchange of critical and timely information among marginalised communities so that it helps in improving their quality of life. It aims to provide connectivity, content and capability*via* a phone-based service. Specifically, it will provide grassroot communities with access to wide information and knowledge pool.

OneWorld South Asia (OWSA) with the support of British Telecom and CISCO systems is piloting the service in North India in partnership with other civil society organizations. British Telecom and CISCO Systems have supported the initiative as a part of their Corporate Social Responsibility programme which assumes that access to Information and Communication Technologies (ICTs) can improve people's lives and open doors to education, jobs, entertainment and interactions. The technology solution development has been supported by Tech Mahindra and WIPRO.

The farmer calls a designated number using a land line/mobile telephone. The call first reaches the Interactive Voice Response System (IVRS) where she/he registers the query with the help of a voice menu. The query is stored as a voice clip in a database server. The knowledge worker (KW) logs in to the application through a web interface, views all the calls that are waiting for attention, and searches the FAQ database for the answers. If the KW finds the answer, it is retrieved and stored in the IVRS. If the answer is not found, the KW forwards the question to the subject matter experts. Once a response is received from any of the subject matter experts, the application alerts the KW, who examines the response and if appropriate, stores the answer in the database and makes it available for future queries. Voice Clip of the answer is played back to the farmer when he/she calls back.

The information can also be retrieved in text format from the Information Centre near the village. The farmers can send pictures along with their questions, and also voice clips to clarify on the issue (Soochna Se Samadhan, 2009).

Lifelines India which was launched in 2006 as an information delivery service at the grassroots was started in 700 villages in north and central India (Lall and Sahi, 2009), in partnership with Indian Society of Agribusiness Professionals and TARAhaat. Local volunteers will facilitate the use of the service by the farmers. The farmers can also visit the nearest information centre to access the offline database in local language, listen to the audio clips and also to send pictures of affected crops (Saravanan, 2010).



(www.solutionexchange-un.net.in/decn/cr/res05110601.doc)
Fig. 12: Information Dissemination Pattern in Lifelines India

3.2.2. Fisher Friend

QUALCOMM, M. S. Swaminathan Research Foundation (MSSRF), Tata Tele-services and Asute System Technology jointly implemented mobile based advisory services (instant access to helpful information such as weather conditions, where they can and cannot fish and seeking information on market prices) to fishing communities of costal Tamil Nadu since, 2007. Due to technical challenges, availability of services only 5 nautical miles created mixed impact. Some of successful case studies on mobile services impact were reported by Mittal *et al.*, 2010.

QUALCOMM, MSSRF, Tata Tele-services and Astute System Technology collaborated to develop a Binary Runtime Environment for Wireless (BREW)-based mobile application, which empowers fishing communities in India. Fisher Friend is a mobile application, which is based on QUALCOMM's BREW solution and works on 3G CDMA and WCDMA (Wideband Code Division Multiple Access) handsets. The new application allows fishing communities to use ICT and wireless technology to earn their livelihood. Fishermen can send request form from menu-driven client software on the mobile phone. Fishermen can access vital updates on opportunities, risk and market information in their local language. Presently, the application is implemented in the coastal areas of Tamil Nadu, India. Fisher Friend project aims to be extended to other communities in

the coastal belts of India (News-i4d, 2009).

3.2.3. Indian Society of Agribusiness Professionals (ISAP)- Query Redress Services (QRS)

QRS enables ISAP to provide solutions to farmers' queries pertaining to agricultural practices, problems, productivity improvement, scientific farming and improved technology for production to farming community. This service is based on an Interactive Voice Response System (IVRS), wherein farmers can register their queries by dialing a dedicated number. 'Soochna-Se-Samadhan' is a programme owned by OneWorld South Asia (OWSA) and funded by CISCO and British Telecom. This is facilitated through ISAP field coordinators and ISAP experts provide answers to these queries within 24 hours. The programme is being run in the states of Himachal Pradesh, Madhya Pradesh and Uttar Pradesh. More than 10 000 queries per month from 280 villages are responded under this program (http://www.isapindia.org/static/CurrentProjects.aspx).

3.2.4. IFFCO Kisan Sanchar Limited (IKSL)

Through voice messages in local languages. 95 000 voice messages have been delivered and 81 000 Q&A repository with 5 000 feedback messages from the farmers have been received. 1.3 million active farmers are benefiting from IKSL's Value Added Services and IKSL enrollment has crossed four million with forty thousand cooperative societies operating as IKSL Retailers (www.iksl.in).

Bharti Airtel Limited, India's leading integrated telecommunications services provider, and Indian Farmers Fertiliser Cooperative limited (IFFCO) launched a joint venture company IFFCO Kisan Sanchar Limited (IKSL) in 2008, that is set to provide a major boost to Indian agriculture and the rural economy at large. The joint venture company will harness the power of telecom to add value to the farm sector and empower the rural farmer by giving him access to vital information, which will enhance his livelihood and quality of life. Innovative telecom products and services, especially created for the farming community, will enhance their productivity and play a bigger role in India's growth story. The Indian farmer can now look forward to the benefits of mobile telephony and mobile internet through this initiative. Synergizing on IFFCO's presence in about 98 per cent of villages throughout the country, Airtel would use IKSL as a vehicle to make its mobile telecom services reach the rural masses (IFFCO, 2008). IFFCO Kisan Sanchar Ltd. is, therefore, a unique venture to strengthen the Cooperative movement in rural India, to empower the farmers through information, to boost the rural economy, and also to create rural employment. IKSL will offer products and services, specifically designed for farmers, through

IFFCO societies in villages across the country. On offer will be affordable mobile handsets bundled with Airtel mobile connection. The farmers will also get access to a unique VAS platform that will broadcast five free voice messages on mandi prices, farming techniques, weather forecasts, dairy farming, animal husbandry, rural health initiatives and fertiliser availability *etc*. on a daily basis. In addition, the farmer will be able to call a dedicated helpline, manned by experts from various fields, to get answers to their specific queries. This is

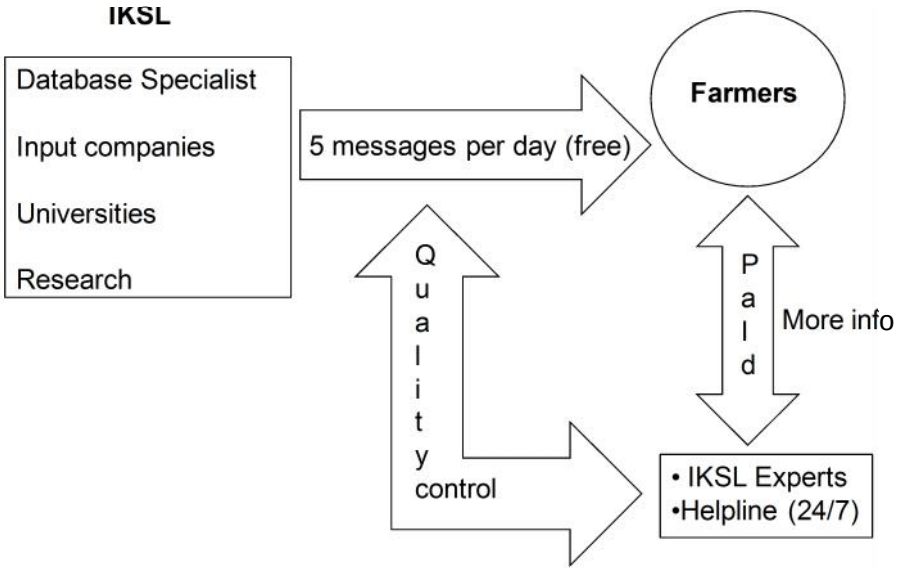


Fig. 13: Information Dissemination Pattern in IKSL

expected to promote community building within the society and rural community at large (http://www.iffco.nic.in).

3.2.5. Reuters Market Light (RML)

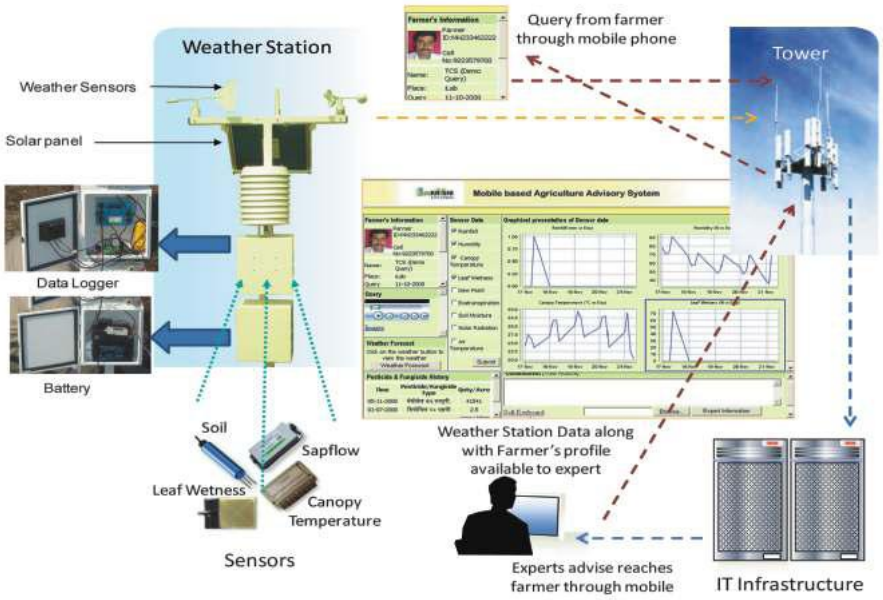
Micro-information Services designed specifically for the farming community was launched by RML in 2007. It currently covers over 440 crops and varieties with more than 1 400 markets and 2 800 weather locations of 15 000 villages in 13 States of India. Timely and personalized information and individual farmers have reaped significant return on their investment achieving up to INR 200 000 ($ 4 000) of additional profits, and savings of nearly INR 400 000 ($8000) by using RML (www.reutersmarketlight.com).

3.2.6. Farmers' Helpline by Chambal Fertilisers and Chemicals Limited

Telephonic help lines called “Hello Uttam” have been set-up. Farmers can raise issues over phone by calling one of the local numbers of “Hello Uttam” helpline (http://chambalfertilisers.in).

3.2.7. mKRISHI by TATA Consultancy Services

mKrishi sucessfully pilot tested in Maharastra (Pande and Arve, 2009) and Punjab (Pande *et al*., 2011). mKrishi is having three combimnation of services using Interactive Voice Response System (IVRS), mobile based and automatic weather station information integrated service to the farmers (http://www.tcs.com). Initially mKrishi was pilot tested among the grape growing farmers of Bargaon village in Maharastra state of India. Camera enabled mobile phones with mKrishi aplication software were distributed to the farmers. Automatic weather station with weather, soil and leaf wetness sensors were installed at the farmers’ fields. This set-up was connected to a wireless modem to send the dynamic weather and soil information to the expert over a cellular network. The camera in the mobile phone was used to send high resolution



(Pande *et al*., 2011)

Fig. 14: Integration of Several Technologies for mKrishi Solutions

pictures of the crop to the experts. Farmers uploaded fertilizer and pesticide history of the crop through the mobile phone having mKrishi client application software. A local person was deputed to assist the farmers to feed the information throrugh the mobile. Remotely located experts from the Rallis

(A Tata Company) got the farmer specific information and provide personalised advisory to the farmers. The mobile software design interface was provided in the local language. During the nine months of field trial, farmers opined that the mKrishi service was very useful, especially during the critical stages of the crop growth (Pande and Arve, 2009).

Pande *et al.*, (2011) indicated that "mKrishi has been successful in taking the *farm to the expert* rather than asking expert to visit farm". mKrishi solutions ha ower,

(Pande *et al.*, 2011)

Fig. 15: Schematic Diagram of the mKrishi Information and Advisory Solutions

CDMA technology, Global Positioning System, mobile handset with camera, handset application environment, expert console software servers, and application engines for content localisation (Pande *et al.*, 2011).

The second phase of mKrishi deployment was carried out in the state of Punjab by the Reviving the Green Revolution (RGR) initiative of the Sri Ratan Tata Trust (SRTT) and Punjab Agricultural University. mKrsihi was implemented among 120 farmers in six villages for disseminating best practices along with the Decision Support System on IPM for Cotton and Wheat crops. The project funded 80% subsidy for a handset to a farmer and the farmer need to pay a subscription fee Rs. 100 per month. mKrishi enabled farmers to send queries

(text/vice/pictures) to the experts by using mobile phones, and experts at the remote location (Punjab Agricultural University) can view or listen the farmers' queries with the dashboard view on farmers' profile, farming history and other farm field data which enabled better services to the farmers (Pande *et al*., 2011).

3.2.8. Nokia Life Tools

Nokia Life Tools is a range of services which include agriculture, education and entertainment services designed specially, for the consumers in small towns and rural areas of the emerging markets. The service provides timely and relevant information customized to the user's location and personal preferences directly on their mobile phones. Nokia Life Tools Agriculture services aim to plug the information gaps and needs of farmers by providing information on seeds, fertilizers, pesticides, market prices, and weather (temperature, rainfall, wind

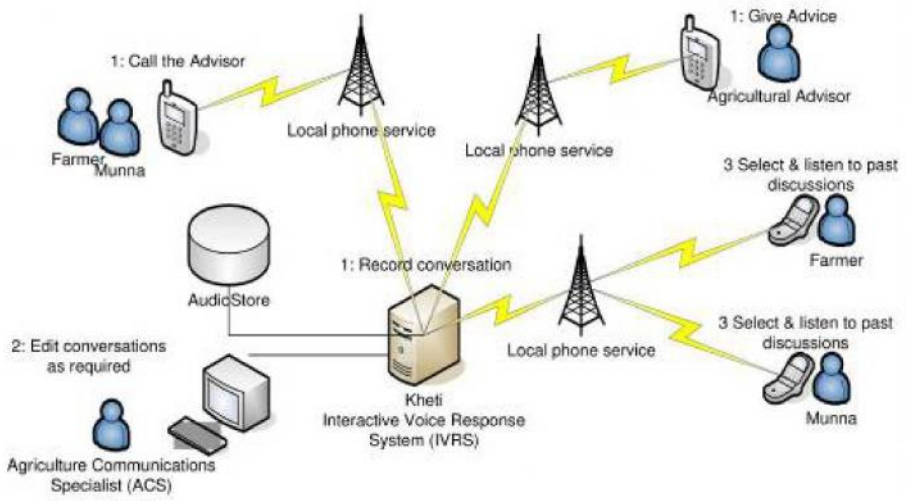
(Blom, 2009)

Fig. 16: Nokia Life Tools

conditions) *via* their mobile phones. Information on weather, agriculture tips and techniques, as well as market prices are provided to improve farmers' productivity and earnings. Farmers are empowered with tailored and reliable information in sync with the cropping cycles delivered regularly to their mobile phones (http://www.nokia.co.in/explore-services/nokialifetools).

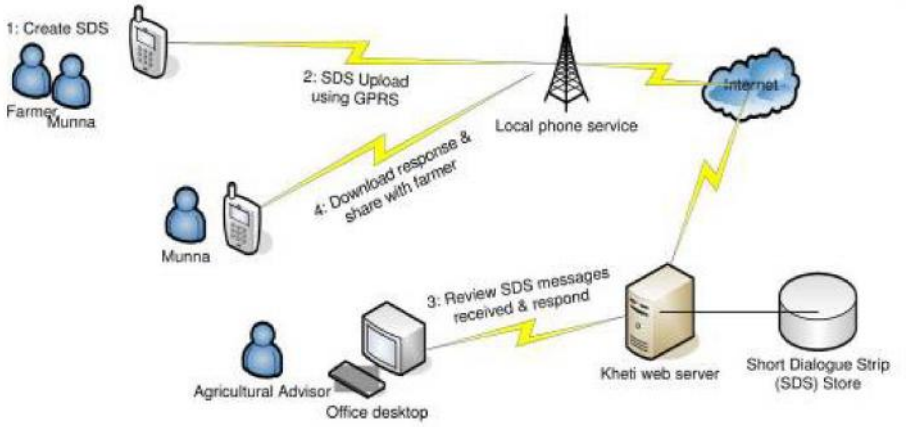
3.2.9. KHETI (Knowledge Help Extension Technology Initiative)

KHETI, has been implemented since August, 2008, by the Sironj Crop Producers' Company (SCPCL), which is a co-operative of small farmers from the villages around Sironj in Madya Pradesh State of India with the financial support from the UK Engineering and Physical Science Research Council. KHETI provided solutions by integrating mobile phones, the internet and desktop computers, and



(Dearden *et al*., 2012)

Fig. 17: Kheti-Using the IVRS System



(Dearden *et al*., 2012)

Fig. 18: Using Short Dialogue Strips to Seek Advice

also by using Interactive Voice Response System (IVRS) (Dearden *et al*., 2012). The main features of KHETI solutions are: members' profiles, member land details, crop POP profiles, Short Dialogue Strips (SDS), synchronising conversation of mobile with server and recording conversation by mobile, transfer of conversation from mobile to server (Rizvi, 2010).

Kheti software has three major components: a mechanism for recording and logging telephone conversations between the farmers and the advisor, software

on mobile camera phones to create Short Dialogue Strips (SDS), and web database of the farmers. The local facilitator (service provider) called "Munna" was responsible to visit 5-6 villages at least once a week to each village with the camera enabled mobile phones. Five local facilitators regularly visited 28 villages and initiated the discussion with the farmers. Based on the discussion, farming issues were identified and SDS were created by the facilitators and sent for expert advice. Next morning, based on SDS information, a conversation between an expert and a farmer takes place through the facilitators' mobile phones (Dearden *et al*., 2012).

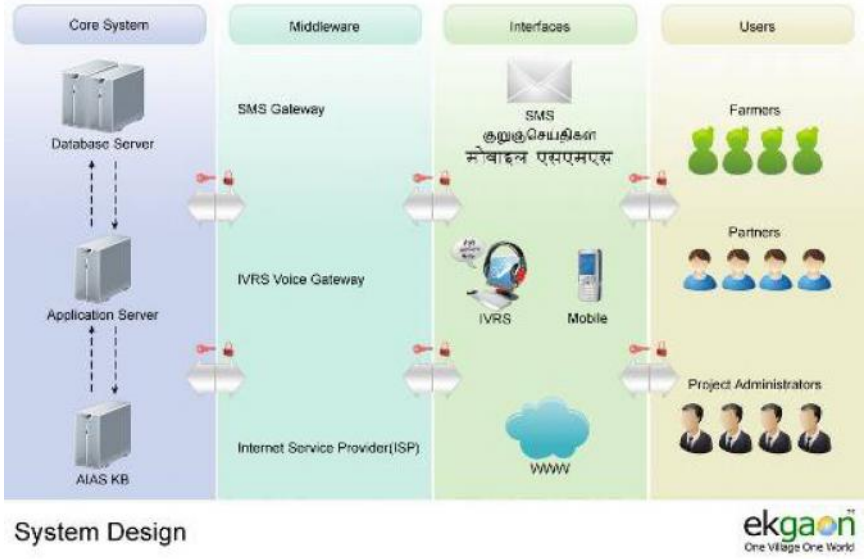
3.2.10. Behtar Zindagi (Better Life)

Behtar Zindagi was conceived by the Handygo' product team and based on Interactive Voice Response System (IVRS) on mobile in the regional languages to reach the rural population to deliver voice based information services on improved package of practices in agriculture. Information on commodity prices (mandi rate), weather forecast & agro-met advisory, advisory for fisherman & management of inland fisheries, managing livestock, women & child health, HIV & STDs and towards reducing mortality rate, rural finance & ongoing Govt. schemes, education & self employment options in rural sector are also provided. The service can be accessed by dialling the number 556780 (toll free) from a mobile phone. The key features of voice based mobile rural service - "Behtar Zindagi' are: Information delivery in 20 regional languages covering a wide range of information touching every aspect of rural life, content sourced from Govt. institutions and state level universities, giving platform to many Govt. organizations to disseminate information, state level content segregation delivered through regional voice based menu, irrespective of whichever handset used and 24X7 availability. Behtar Zindagi provides state wise information on cultivation practices on all the major crops, best practices, recent technologies, integrated farming system, animal husbandry and dairying and livestock integrated farming system. Costal fisheries advisory is a unique voice based service for the fishermen of India and the fishermen can find out the Potential Fishing Zones (PFZs), wind speed, wave height, cyclones and earth quake alerts across eight states having costal area by dialling the number 556780 (toll free) from mobile (Jain, 2011).

3.2.11. Mobile based Crop Nutrient Management Decision Support System

Ekgaon Technologies and Farmers Federation (Kazhi Kadamadai Farmers Federation-KKFF) implemented a pilot project to provide simple, customized and effective last mile accessibility tool for nutrient inputs and management in paddy cultivation by using Short Message Service (SMS) and Interactive Voice Response System (IVRS) through mobile phones, and also provides detailed

information through web pages (Raj *et al*., 2010). The project was applied to 216 farmers who are members of KKFF in five villages of Nagapattinam district of the state of Tamil Nadu in India. Data on farmers' fields, crop and nutrient management history was collected by field survey using interview schedules and supplemented by farmers' meetings and focussed group discussions. Based on farmers' field and crop data, SMS/ voice alerts were delivered to the registered mobile phones of the farmers. These alerts were synchronized with the age and date of sowing of the crop. Through this system each farmer received approximately 106-110 SMS alerts on crop cultivation practices with nutrient management advice during the cropping season of four months. Every



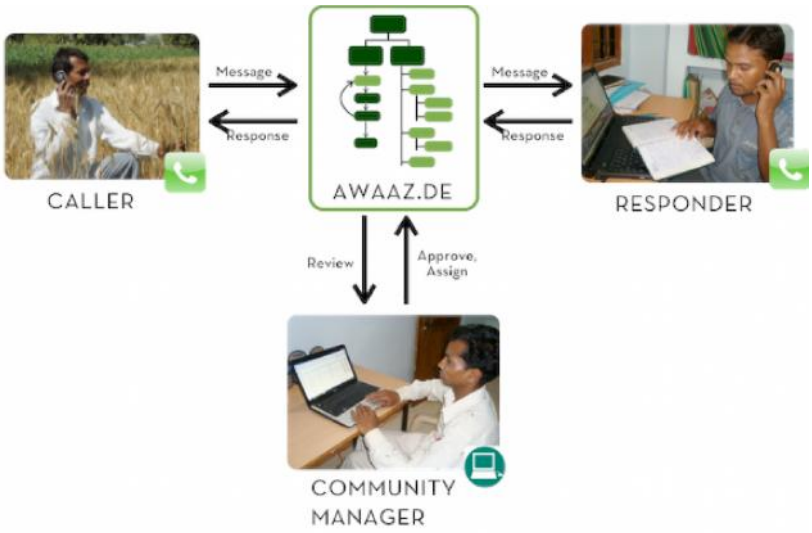
(Raj *et al*., 2010)

Fig. 19: Mobile based Crop Nutrient Management Decision Support System Design

farmer was visited fortnightly to verify whether they have implemented all the alerts received by them and at the same time, whether they had sent the implementation reports to the server. The confirmation on field activity by the farmers has been facilitated through SMS and IVRS and automatically updated on the central data base on a real time basis (Raj *et al*., 2010).

Impact assessment among the registered farmers and control group indicated that farmers using this system were able to increase their income by 15% and got Rs. 475 (USD 42.5) additional income per acre in a four month cultivation period (Raj *et al*., 2011).

3.2.12. Awaaz De (Give your voice)



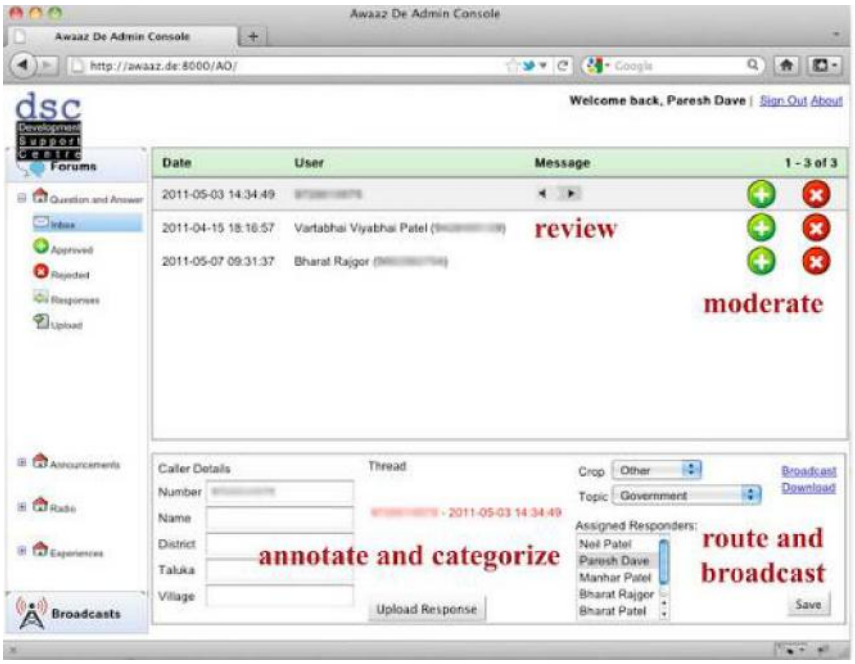
(http://www.mobileactive.org/mobile-tools/awaazde)

Fig. 20: Schematic Diagram of Awaaz De Software Platform

Awaaz. De is a software platform enabling organizations to engage with poor, remote, and marginal communities by providing on-demand, many-to-many information access through mobile phones. People access Awaaz.De applications by dialling regular phone numbers to create, browse, and share voice (http://awaaz.de).

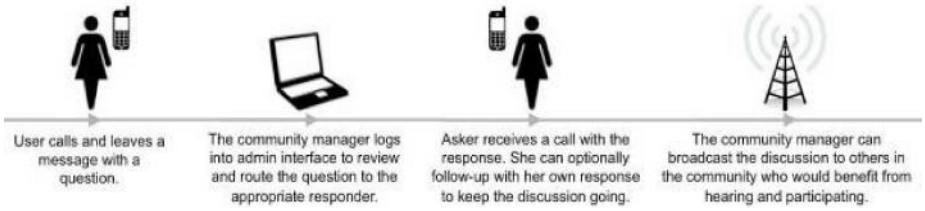
It is centered around Awaaz.De's voice message broadcast functionality. With streams, anybody can create a stream or voice message group, which is accessible over a unique, dedicated phone number. Then they need to add members to join particular stream, and they get a welcome SMS with a reminder that they can unsubscribe at any time by calling the dedicated number and pressing number 9. Then they post a voice message on the fly*via* phone by calling the stream's dedicated phone number, or web upload. Next, each of their group members automatically gets a phone call to listen to the message. In case they miss the call or their phone is off, they can call back the stream's dedicated number and listen; an SMS notification follows each broadcast phone call. Non-members can request to join in the group by calling the dedicated number and submitting a join request. One way to think of streams is a Voice Twitter.

Streams allow two-way communication between a member and their group members. Members can record voice message responses to the broadcasts, enter touch-tone input or can call into the dedicated stream phone number to give their voice.



(http://www.mobileactive.org/mobile-tools/awaazde)

Fig. 21: Schematic Diagram of Awaaz De Admin Console



(http:/mobileactive.org/mobile-tools/awaazde)

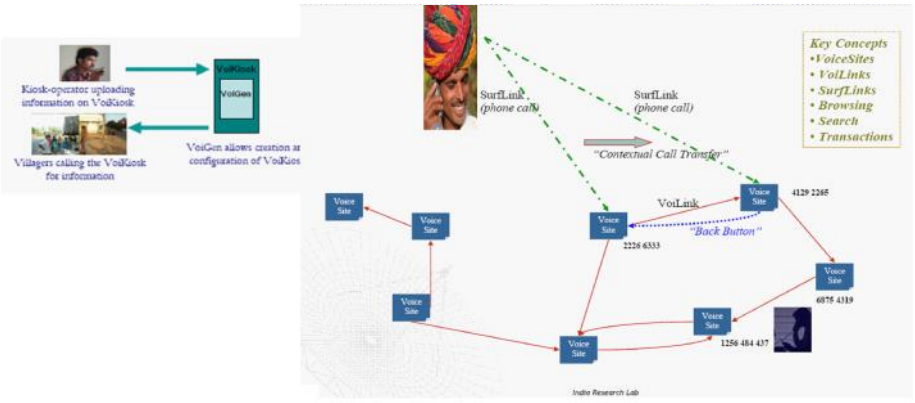
Fig. 22: Schematic Diagram of Awaaz De Working Mechanism

From the web, streams allows one to create groups, schedule broadcasts, listen to community member responses, manage group membership, upload a custom greeting message, and more. Setting up a stream is absolutely free, and it takes only a few seconds. After setup, one can choose to have pay-per-usage or free stream (http://awaaz.de/2012/08/announcing-streams/).

3.2.13. Spoken Web

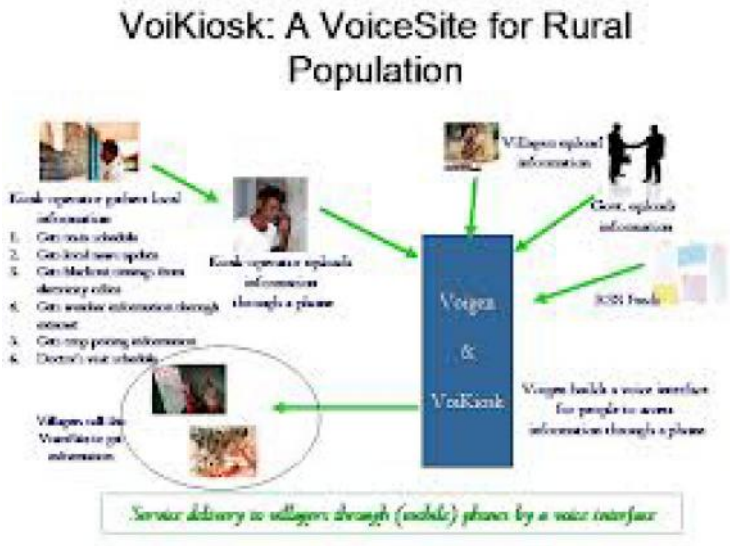
VoiKiosk (Avaaj Otalo) is like voice-based information kiosk or voice

based portal. VoiKiosk is designed and developed by IBM Research to reach out to masses based on oral communication, which is the forte of a country like India. Voikiosks are a central point of access for a community where information relevant to the community can be posted and accessed directly by the users



(IBM-ILRI Workshop Brochure, 2010)

Fig. 23a: Architecture of VoiKiosk



(www.engineeringforchange.org)

Fig. 23b: Architecture of Voikiosk

themselves. This solution doesn't rely on internet connectivity. It allows end users to directly interact with the services removing the dependence on the kiosk operator. VoiKiosk is a voice based service available on the Telecom network and based on World Wide Telecom Web technology (http://manthanaward.org/section_full_story.asp?id=669).

The basic principle of Spoken Web lies in creating a system analogous to the World Wide Web using a technology most of us all have in common - speech. Spoken Web helps people create voice sites using a simple telephone, mobile or landline. The user gets a unique phone number which is analogous to a URL and when other users access this voice site they get to hear the content uploaded there. Interestingly, all these voice sites can be interlinked creating a massive network, which can work like the World Wide Web. Spoken Web has a huge potential in the developing regions, where most of the people are either illiterate or cannot afford a PC, but many of them own a mobile phone and can speak in their local language (http://www-07.ibm.com/in/research/emergingsols_research.html). A study conducted by Cole and Fernando (2012) on cotton farmers in Gujarat indicated that Awaaz Otalo (AO) was the main source of information among the farmers (58%) who knew about the service and accessed it by a toll free number and preferred it to public extension service and sources like fellow farmers, input dealers, *etc*. It was also observed that the farmers after accessing the service were more aware about usage of pesticides and avoided the hazardous ones, opted for diversity of crops and developed a wide knowledge base after accessing the service.

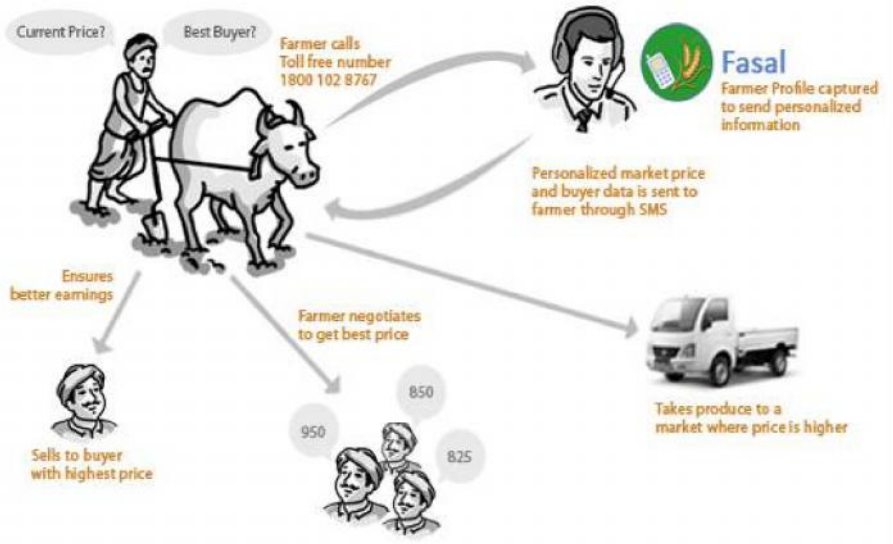
3.2.14. Mrittikka

Mrittikka is a mobile phone and web-based online/offline application for the soil nutrient analysis and recommendation to the farmers. Mrittikka is a joint venture between Grameen Intel Social Business Limited and eKutir Social Business, Orissa, India. Based on the type of crop, soil type, size of the land, planting season, and irrigation access, Mrittikka recommends specific fertilizers and application amounts along with proper application method, source of fertilizer availability and cost estimation (www.grameen-intel.com/products/agriculture/mrittika).

3.2.15. Fasal

Fasal is a free SMS based product connecting rural farmers to buyers and provides them up-to-date price information. Fasal, which started in 2008, establishes buyer-seller connection using SMS. The service is currently available in Gujarat, Andhra Pradesh and Karnataka. Farmers can register by calling a toll free number to the local language call centres at 1800 102 8767 and a Fasal

agent creates a profile of that farmer with location, crops grown, farm size, cropping dates, personal assets, annual income, *etc*. The farmers then receive personalised SMS based on his crops and location from time to time. Moreover, Fasal facilitates the relationship between buyer and sellers by finding market places and determining market rates using comples and patented matching



(http://fasal.intuit.com/index.html, 2013)

Fig. 24: Fasal Project Working Mechanism

algorithms and creating an online marketplace. Farmers can also access the call centres any time at the toll free number. More than 1.5 million farmers are currently registered to the service and the income level of the farmers accessing the service has been found to increase by around Rs. 15,000 (USD 250)per month (http://fasal.intuit.com/index.html, 2013).

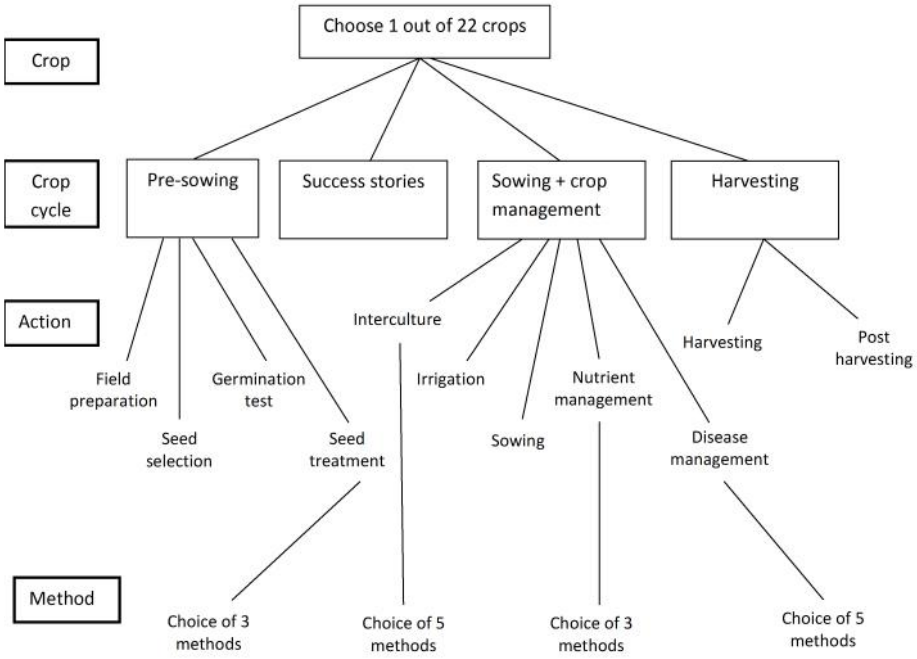
3.2.16. KRIBHCO Reliance Kisan Ltd. (KRKL)

A Joint venture of Krishak Bharati Cooperative Limited (KRIBHCO) and Reliance Communication Limited, KRIBHCO Reliance Kisan Ltd. was launched in 2009 to provide value added services related to agriculture to the farmers of rural India. KRKL aims to create a distribution model that will cover 72 per cent of the rural population through its network of over 25 000 cooperatives, 6 300 member cooperatives and 60 Krishi Seva Kendras (Reliance, 2013).

3.2.17. Videokheti

Videokheti, developed by Microsoft Research India in collaboration with Digital

Green, an NGO, is a multimodal interface with speech, graphics, and touch on a smart phone or tablet designed to make available to the farmers agricultural videos on a click and in their own dialect. There are a total of 147 videos are



(Cuendet *et. al*., 2013)

Fig. 25: Navigation tree of the application

(Cuendet *et. al*., 2013)

Fig. 26: A screenshot of the application

available in the application for 22 crops classified and organized in four levels according to their content: crop, crop cycle, type of action, and type of method. The four levels are organised in a navigation tree for easier user interface. It uses SALAAM Automatic Speech Recogniser (ASR) to create a multimodal interface with speech, touch and graphics to make it easy-to-use for low literate farmers in rural areas.

In the study conducted by Cuendet *et al*. (2013) to understand the effectiveness of the application in rural settings, it was found that the higher literates were more efficient in handling the application than the lower educated ones. Even in understanding the voice guided navigation, the well-educated were better. However, the tendency to use speech navigation was more, compared to graphics among the respondents.

3.2.18. Mandi Bhav

Launched jointly by Tata Teleservices and Impetus Technologies, Mandi Bhav is a value added service aimed at providing commodity prices to farmers in rural areas. Available to Tata Indicom subscribers, Mandi Bhav provides real time market prices to farmers and commodity traders from approximately 3000 local commodity markets across the country for about 500 major commodities on various platforms like J2ME (Java 2 Platform, Micro Edition), BREW, Wireless Apllication Protocol (WAP) and SMS charging Rs 30 (USD 0.5)per month for this service. The application supports Hindi, English and Marathi with plans of adding more languages irrespective of the handset model (The Financial Express, 2009).

3.2.19. Kisan Sanchar

Initially started for informing daily prices of Basmati rice to farmers under Contract Farming Project in 2008, Kisan Sanchar by Srishti Gyan Kendra, a Rohtak based NGO, at present caters to 34,483 farmers in seven states of India. Mobile based field advisory services are provided to the registered farmers free of cost on their crops and allied professions. The service is sponsored by Indian Council of Agricultural Research and is provided in collaboration with ten State Agricultural Universities and their KVKs. At the beginning, the SMS alerts were sent using SMS plan of service providers and a specific number so that farmers would not get confused. Later the system was changes to online content management. Even though the service is free for farmers, any institution willing to provide the service to farmers have to pay Rs. 3 000 (USD 50) as annual registration fee. Due to this service, Haryana State Co-operative Supply and Marketing Federation Limited (HAFED) is now able to procure paddy from 90 per cent of its contact farmers whereas earlier, it was able to procure from only 15-20 per cent of them (Mittal, 2012).

3.2.20. Warana Unwired

This project by Warana Cooperative, a sugarcane farmers' group and Microsoft Research India was launched in January, 2006, and was functional till November, 2007. The project was mainly an up-scaling of the previous Warana Wired Village project where agricultural information was passed on to the farmers of the region through kiosks. But in the up-scaled version, mode of information transfer was mobile phones with the aim of making it faster and efficient.

An SMS alert is sent through SMS toolkit which provides a PC-based programmable interface to SMS messaging *via* a connection to an SMS sending/ receiving port. A single PC is connected to the Warana Cooperative's server,

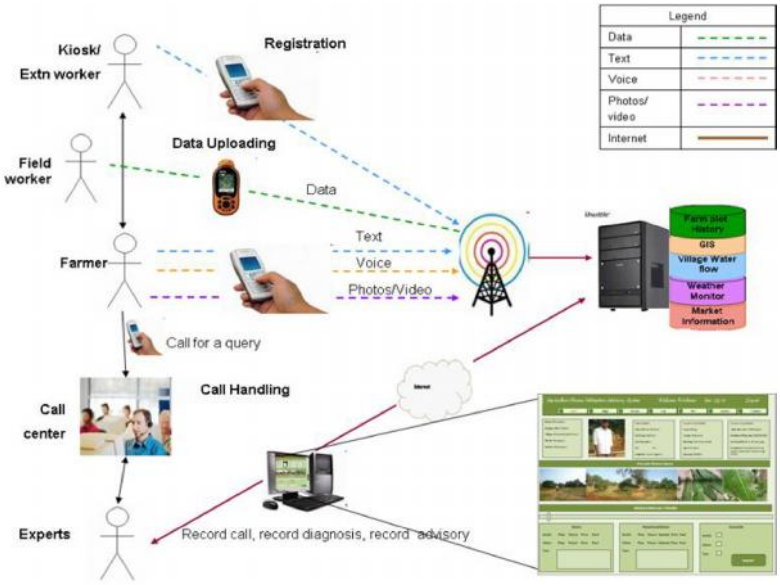
(Veeraraghavan *et al*., 2009)

Fig. 27: Warana Unwired Working Mechanism

one Windows mobile smartphone as a server phone is connected as SMS sending/ receiving port and a number of cell phones are used to replace the PC's in the village kiosks. The SMS toolkit provides a software filter to intercept the incoming messages which are forwarded to the agent running in the PC. Farmers and kiosk operators send messages via basic mobile handsets to the server phone. The server system receives the message and looks up the information in the database. The gateway then sends back a reply SMS containing the information requested (Veeraraghavan *et al*., 2009).

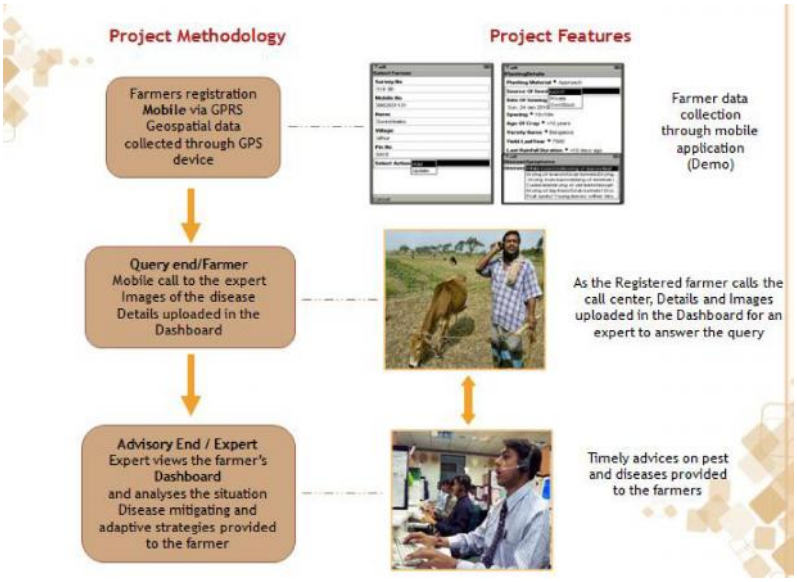
3.2.21. Mobile Multimedia Agriculture Advisory System (MAAS)

Launched in 2009 by the Indian Institute of Technology – Madras (IIT-M), Tamil Nadu Agricultural University (TNAU) in collaboration with National Agro Foundation (NAF), Erode Precision Farm Producer's Company Ltd. (EPFPCL),



(Sriram *et al*., 2013)

Fig. 28: Schematic Diagram of Mobile Phone based Data Collection and Periodical Updates of Farming Details



(Sriram *et al*., 2013)

Fig. 29: Flow Chart on Farmer's Registration and Expert's Advisory to the Farmer

Dharmapuri Precision Farmers Agro Services Ltd. (DPFASL) and sponsored by Indian Council of Agricultural Research – National Agricultural Innovation Project (ICAR-NAIP), the basic objective of the initiative is to provide multi-media agro-advisory to the farmers through SMS and voice based interactive system. The service is further strengthened by Global Positioning System (GPS) and Geographical Information System (GIS) to further strengthen the data source for more personalised information. The system does not develop any agricultural information but helps the farmers to get in touch with agricultural experts for answers to their queries (TNAU, 2013).

3.2.22. Kissan SMS Portal

With the aim of reaching agricultural information, advisories and services to more than 120 million farm families of the country, the Government of India launched Kissan SMS Portal (www.farmer.gov.in) in 2013. SMS regarding weather forecast, weather alerts, advisories on outbreak of disease/pests of plants and animals, crop advisories on appropriate technologies suited to local situations, *etc*., advisories on new or most suitable crop variety/ animal breed, market information, information on schemes and programs of Government of India and soil test results will be delivered to the farmers completely free of cost. Language opted by the farmer at the time of registration will be used for sending the messages (PIB, 2013).

3.2.23. Mahaagri SMS

This techno-social networking project is launched by Department of Agriculture, Government of Maharashtra. A total of three lakh farmers from forty-thousand villages have registered for the service since its launch on August, 2009. Advisory dissemination for market intelligence and for price realization of farm produce through scientific storage facilities and commodity markets for farmers is being integrated in this service in collaboration with state Marketing Board and State Warehousing Corporation. Indian Agro Meteorology Department delivers location specific Agro-met advisory to the farmers. Under this project, SMS can be sent to the farmers by Block/Taluka Agriculture officer, Sub-Divisional Agriculture Officer, District Superintending Agriculture Officer, Divisional Joint Director, Director Agriculture, Commissioner of Agriculture, Secretary of Agriculture and scientists from State Agriculture Universities. From April, 2012 to July, 2013, 58.5 million messages were sent to the farmers under the project (DoA, GoM, 2013).

3.2.24. aAqua Mini

Designed for the mobile browser and working in a revenue generating model, aAqua Mini is the handset compatible version of aAqua by Agrocom and designed by Development Informatics Lab at IIT Bombay. The services are broadly to the farmers and include localized crop diagnostic solutions, audio prompted guide application in English, Hindi and Marathi, disease diagnostics based on remote crop and land properties, micro weather information and SMS enabled register and query mechanism on GSM and CDMA networks.

3.3. Other Mobile Applications in Agriculture

3.3.1. mFMS

Mobile based Fertilizer Monitoring System (mFMS) is a mobile based tracking of fertilizer movement up-to retailer level. Daily fertilizer stock and sales information by the wholesalers and retailers will be documented. mFMS facilitates web, mobile and IVRS based access channels for the stakeholders (http://mfms.nic.in).

3.3.2. Nano Ganesh

Nano Ganesh is a mobile based remote control system for controlling water pumps. The device has been designed to help farmers save time, water and energy and increasing crop yields. Nano Ganesh is manufactured by the Ossian Agro-Automation Pvt. Ltd, India. Calls made to the pump are free to the farmer (http://www.nanoganesh.com/).

4. An Analysis on Mobile for Agricultural Extension Projects in India

4.1. Public Vs Private Initiatives (Free Vs Business Model)

Among public sectors, research-extension organisations (ICAR-KVKs), University (Tamil Nadu Agricultural University) and commodity based research and development institute (Rubber Board) providing services in colloboration with information technology and software solution providers such as; Bharat Sanchar Nigam Ltd (BSNL) and Centre for Development of Advanced Computing (C-DAC) were collaborating with content providers. Interestingly, private initiatives are from the NGOs (MSSRF, IASP *etc*.), Co-operatives (IFFCO), and also from the business firms (Airtel, Nokia, TCS, Thomson & Reuters *etc*.). Almost all the private players are exploring business model by value addition in the information services and hence, innovating continuously like mKrishi of TATA Consultancy Services. But, unfortunately, most of the

mobile based agro-advisory initiatives of the public sector provide routine information with limited refinement and validation (Refer Annexure I for the public-private m-agriculture initiatives in India).

4.2. Content Generation

The public sector mainly relies on their research resources (like universities and ICAR institutes) for content generation but private sectors appoints dedicated teams to generate location specific information and some of the them engaging in partnerships with others who can provide better content (like Life Lines of India having association with Indian Society of Agribusiness Professionals (ISAP).

4.3. Partnership

Most of the mobile based projects had partnership with information technology solution providers and agricultural technology experts like TNAU- C-DAC, private mobile software solution providers and KVKs, Airtel-IFFCO *etc*. Collaboration ensures better looking-after of the information needs of the farmers and ensures a sustainable, as well as dynamic portal where the information is updated regularly.

4.4. Information Coverage

Market and weather information and crop advisory are generally given by most of the mobile based advisory services. However, preliminary analyses of Lifelines of India indicate that majority (57 per cent) of the questions are on horticulture sector followed by field crops (27 per cent) and animal husbandry and dairy (5 per cent).

4.5. Sustainability & Scaling-up

Few projects like IFFCO Kisan Sanchar Limited and Lifelines of India sustains (system and financial sustainability) over the years and continue to expand their services to the larger clients. However, most of the other projects are stuck in pilot basis or not scaled-up. Projects like Warana Wired Village have been up-scaled to Warana Unwired and pilot tested but has not yet been applied on a long-term basis.

4.6. Cost Effectiveness

A sustainable revenue generating model as in aAqua, IKSL, Nokia Life Tools, RML, SMS broadcast Service of KVK, Bhabaleshwar, Fisher Friend, *etc*. is the main reason behind their sustainability for over a long period and benefits

the farmer ultimately. Even the farmers and subscribers are voicing the same concern saying that the utility of the SMS alerts are more when they come with a cost rather than free of cost (Bhaskar, 2013).

4.7. Voice Vs Text

The literacy rate of India might show an upward trend but as of now, there are many farmers in rural areas who are illiterate or functionally illiterate as was found in the study on KMAS in Meghalaya and for them, a voice or speech guided system is far more effective than a simple text. In the preliminary study of Videokheti, the researchers also experienced that the participants were more interested in using the voice command rather than using the touch interface to navigate among the videos in the application. The integration of IVRS is found to be a common trend in most of the mobile based advisory system which is also an indicator of the same.

4.8. Add-ons, Not Replacements

The projects for mobile based advisory systems have been found to be add-ons rather than replacement of the existing ones with the negativities addressed. Sustainability of the advisory systems beyond project period and without the continued funding has been a problem with extension in India . While private approaches like IKSL, Lifelines of India, RML are expanding their user base, other projects are just being piled up in the growing list of mobile based advisory services.

4.9. Research on impact

Impact studies of the projects after a certain period of project implementation has been insignificant. Even though the number of subscribers is listed and updated, studies regarding the actual impact of the project on the socio-economic condition of the subscribers have been less. Individual researches have been conducted for Kisan Call Centre, IKSL, Lifelines of India, Spoken Web, *etc*., but the integration of research to find-out the impact as in m4agriNEI has been taken up by very few projects.

5. Key Ingredients for Success of the Mobile for Agricultural Advisory Services

5.1. Partnership

Partnership with appropriate content generators and software solution providers will be the key for success of the mobile based agricultural advisory services.

5.2. Content

Location specific and farmer specific contents are more useful to the farming community than generalised contents. Further, additional information like availability of fertilizers and pesticides in local areas, as found in the study on KMAS in Meghalaya, is highly regarded and required by the farmers.

5.3. Media Mix

In addtion to text messages, voice, image and multimedia based services need to be initiated to sustain momentum in the mobile advisory services, make them more interactive and change with the changing needs of the next generation users and mobile phones.

5.4. Innovation

Continued innovation and appropriate mobile application development is necessary to ensure the sustainability of the services. Agricultural information has moved beyond 60-80 character SMS and voice, pictures and videos are more in demand. Development of applications for smart phones as well as medium range phones can go a long way in increasing the effectiveness and popularity of the service with mobile phones getting cheaper every day.

5.5.Timeliness

Timeliness is a factor that impacts agricultural information to a great extent. Late or too early messages do not have much utility for the farmers and ultimately the service loses its credibility.

5.6. Quality and Credibility

The quality of the message sent to the farmer, irrespective of the format, determines to a great extent the success of the service provided. Personalised and location specific messages have more utility than general ones; real time market price of commodities, price forecasts; weather and disease and pest attack forecasts are much more desired than preventions. The credibility of the service providers among the clientele is imporant for the sustainability of the services.

6. Lessons

Most mobile based projects were operational as pilot projects. Except few (IKSL, LifeLines India) most other projects were operated in a small scale. Systematic impact studies are yet to be conducted. However, some of the private initiatives are making a lot of promise for scaling up with innovative business model (like IKSL). At the same time much hyped projects like Reuters Market Light (RML) evaluation report by the experts from the Oxford University and International Food Policy Research Institute (IFPRI) indicated no significant impact among farmers due to mobile based market information services (Fafchamps and Minten, 2012). At the same time farmers are paying for the services of the IKSL where they feel value for agricultural information and farmers' enrolment is continuously increasing. An evaluation of Avaaz Otalo on cotton farmers in Gujarat showed that the information source of the farmers for taking major agricultural decisions changed from peer groups to the mobile advisory service once it established credibility with the farmers. This indicates the behavioural change of subscribers by reliable mobile advisory services. But again, some attempts have failed to register with the subscribers like KMAS of some of the KVKs as they did not properly address the needs of the farmers. The need of information as text messages have changed and farmers are more interested in voice, pictures and videos which give them a better idea about agricultural methods and practices. With these needs, the services have evolved fast. Kisan Call Centre, which was basically a land line (wired phones) based pull service has given way to mobile applications for high end smart phones; basic text messages in KMAS, mKrishi, *etc*. have evolved to voice messages (IKSL) to multimedia content (m4agriNEI) to mobile applications (Videokheti). The use of basic phones are reducing and making way for Enhanced Data rates for GSM Evolution (EDGE) and General Packet Radio Service (GPRS) enabled smart-phones. Operating systems of mobile phones have evolved a lot with Google's Android, Microsoft's Windows and Apple's iOS. Along with it has increased the opportunity to evolve the research and development in mobile for agricultural and rural development. Applications developed for Apple App Store, Nokia Ovi Store, Nokia Marketplace can be accessed through 2G, 3G and 4G internet connections. And with the prices of smart-phones coming down and user base increasing every day, these applications can go a long way in making agriculture both attractive and profitable. Even the nature of impact studies have changed from mere calculation of user base to increase in income of the subscribers, effect in their socio-economic conditions, their behavioural changes before and after accessing the service to profit of the service providers to make the projects sustainable and take them from pilot experiments to up-scaled sustainable ones.

7. Conclusions and the Way Forward

Along with incredible opportunities, implementation of mobile applications also poses a lot of challenges in India due to lack of mobile friendly and locally relevant digital content, rural mobile infrastructure limitations (network and signal, electricity problem), illiteracy, large number of local languages and tribal dialects. Further, numbers of pilot projects are undertaken in project mode and after the project period sustainability becomes the major hurdle. Hence, instead of standalone projects, mobile based applications need to be integrated with ongoing agricultural extension programmes and methods. Public –private partnerships for project implementation and web to mobile, voice, image and text integrated applications need to be developed to cater to the farmer specific information and knowledge. Mobile based advisory services for farmers will be encouraged from the National Agricultural Research System (Agricultural Universities, Indian Council of Agricultural Research (ICAR) institutions and NGOs) in collaboration with the technology solution providers such as IITs, C-DAC, Private (TCS, Wipro, Nokia, Airtel *etc*). Based on farmers need assessment, location and farmer specific information need to be generated in multimedia format for the dissemination among the millions of farm families. Systematic studies on farmers'

Table 1. mAgri initiatives in India and their particulars

Sl. No.	Mobile Service	Service Provider	Network	Year	Working Mechanism	Nature and type of Agro-Advisory Services	Target User	Business Model
1.	Hello Uttam (http://www.chambal fertilisers.com)	Chambel Fertilizers and Chemicals Limited (Private)	Mobiles Landlines, *etc*.	2000	Toll free telephone number working on IVRS platform	Any queries related to farming can be asked using the helpline numbers	Farmers of Rajasthan, Punjab, Uttar Pradesh and Haryana can access the service	Free of phones, cost service
2.	Via SMS (http:// www.chambalfertilisers .com)	Chambel Fertilizers and Chemicals Limited (Private)	GSM	2000	Push and pull based SMS service	Any crop and market related queries	Farmers of Rajasthan, Punjab, Uttar Pradesh and Haryana can access the service	Free of cost service
3.	Kisan Call Centre(http:// kisancallcentre.org.in/)	DAC, GoI; TCIL and IFFCO (Public & private)	Mobile phones, landline	2004	Accessible on toll free telephone number working on IVRS platform	Any queries related to agriculture are answered at three levels	Accessible all over India	Free service to the farmers by Ministry of Agriculture and Co-operation, Govt. of India
4.	Lifelines of India (http://lifelines-india.net/)	One World South Asia , British Telecom & CISCO (Private)	Mobiles phones, landlines	2006	Innovative mix of telephony, internet and IVRS	Agriculture and advisory services by voice mode through mobile to the farmers by IVRS and web	Farmers of north and central India	Free of cost service

(*Contd.*)

Sl. No.	Mobile Service	Service Provider	Network	Year	Working Mechanism	Nature and type of Agro-Advisory Services	Target User	Business Model
						enabled system. Text information, viewing offline database, listening voice clip can be done from the information centre near to the farmers.		
5.	Warana Unwired (http://research.microsoft.com/en-us/um/india/projects/waranaunwired/)	Warna Sugarcane Co-operative and Microsoft Research India (Private)	GSM and CDMA	2006	Pull based messages	Personalized information about crops and market information	Sugarcane farmers of Maharashtra	-
6.	Fisher Friend (http://www.qualcomm.com/media/videos/wireless-reach-)	MSSRF and QUALCOMM, Tata Tele-services, Astute System Technology (Private)	CDMA	2007	Software application with dedicated icons on mobile phones	Weather forecasting, market price, sea wave height information, fish shoal location via satellite scan data fisher-friend-project)	Fishermen of Tamil Nadu	Free of cost service
7.	IFFCO Kisan Sanchar Limited (IKSL)(http://www.iksl.in/)	IFFCO and Airtel (Private)	GSM mobiles, landlines	2007	SMS, Voice messages and farmers' Helpline on Green SIM cards	On a VAS platform, farmers can know about mandi prices, farming techniques, weather forecasts and fertilizer availability for free.	Service available in 18 states of the country	Free of cost service

(*Contd.*)

Sl. No.	Mobile Service	Service Provider	Network	Year	Working Mechanism	Nature and type of Agro-Advisory Services	Target User	Business Model
						Every day farmers receive 5 messages each one minute long voice messages. Helpline for farmers from Green SIM Card.		
8.	Reuters Market Light (http://www.reutersmarketlight.com/)	Reuters Group Plc.(Private)	GSM	2007	SMS based service	Localized pricing of onion, soybean, pulses, pomegranate, *etc.*, weather updates, agriculture news.	Farmers of Maharashtra and Punjab	Subscription of Rs 175 for 3 months, Rs 350 for 6 months, Rs 650 for 1 year
9.	DMI (Dynamic Market Information) (http://agritech.tnau.ac.in/dmi/2013/)	TNAU & C-DAC, Hyderabad	GSM	2008	SMS to the registered farmers and uploading in e-Agriculture web portals	Daily market information by SMS on 161 perishable commodities from 13 markets of South India.	Registered farmers of Tamil Nadu.	Service is free of cost.
10.	Fasal (http://fasal.intuit.com/)	Intuit (Private)	GSM and CDMA	2008	Push and pull based SMS	Personalized SMS based on crops and location of the farmer; market prices of different commodities of the farmers' interest	Farmers of Gujarat, Andhra Pradesh and Karnataka	Service is free of cost

(*Contd.*)

Sl. No.	Mobile Service	Service Provider	Network	Year	Working Mechanism	Nature and type of Agro-Advisory Services	Target User	Business Model
11.	KHETI	Sironj Crop Producers' Company (SCPCL) and UK Engineering and Physical Science Research Council(Private)	Mobile, landlines	2008	Integrates mobile phones, the internet and desktop computers and IVRS	Any crop related queries	Farmers of Madhya Pradesh	Service is free of cost
12.	Kisan Sanchar (http://www.kisansanchar.com/)	Srishti Gyan Kendra and ICAR (Private & public)	GSM and CDMA	2008	Push based SMS service	Personalized information about crops and allied professions of the farmers are given	Caters to 34,483 farmers in seven states of India and agriculture professionals	Free of cost service
13.	Nano Ganesh (http://www.nanoganesh.com/)	Ossian Agro Automation (Private)	Mobile application	2008'	-	Connected with Tata Indicom mobile phone and a modem that attaches to the starter of the electric pump, it switches on and off the pump starter and also signals the farmers on availability of electricity.	Farmers of Maharashtra	-
14.	SMS Broadcast Service (http://www.kvk.	KVK, Babhaleshwar (Public)	GSM	2008	Farmers receive SMS. Mostly push based agro-advisory	Weather forecast, disease forecast, market information,etc.;	Farmers of Ahmednagar District, Gujarat.(Saravanan	

(*Contd.*)

Sl. No.	Mobile Service	Service Provider	Network	Year	Working Mechanism	Nature and type of Agro-Advisory Services	Target User	Business Model
	pravara.com/)				services.	information on training to farmers' organizations,etc.	R, 2010) SMS to the farmers against Rs. 100 subscription fee for one year	
15.	Avaaj Otalo (Voikiosk/ Spokenweb) (http://code.google.com/p/avaajotalo/)	IBM Research (Private)	Mobiles and landlines		Voice based portal. Portal can be accessed by dialing a number.	Any information related to agriculture can be accessed on the kiosk using a wired or wireless phone.	Accessible in selected villages in Andhra Pradesh	Free of cost service
16.	Kissan Kerala (http://www.kissankerala.net/sms/index.jsp)	Dept. Of Agriculture, Govt. of Kerala(Public)		2009	SMS based information services, voice based Agri. advisory services, and videos though the mobile; both push and pull	SMS based information service, voice based agro-advisory service, videos, SMS alerts regarding schemes, training programs, 'Krishideepam'.	Registered farmers in Kerala	Normal SMS charge as per service providers. Farmers can also use free SMS package by service providers.
17.	mKRISHI (http://www.tcs.com/offerings/technology-products/mKRISHI/Pages/default.aspx)	Tata Consultancy Services	CDMA	2009	mKrishi Lite – IVR SmKrishi Regular – mobile appmKrishi Plus – Weather info using Automated	Information on microclimate, fertilizer dose, market info both in voice activated service and SMS	Registered farmers of Punjab, Uttar Pradesh, Maharashtra, Gujarat, Andhra	Subscription based service (Annual subscription fee Rs. 300).

(*Contd.*)

Sl. No.	Mobile Service	Service Provider	Network	Year	Working Mechanism	Nature and type of Agro-Advisory Services	Target User	Business Model
					Weather Station (AWS)		Pradesh, Tamil Nadu and Rajasthan	
18.	Mandi Bhav (http://hp.bsnl.co.in/circle/vas/gsm/vas_new.html)	BSNL, Tata Tele Services and Impetus technologies (Public and private)	Software application on mobile phones	2009	Available to Tata Indicom subscribers on various platforms like J2ME, BREW, WAP and SMS	Real -time price updates from different commodity markets (mandis) based on the list of states, markets and commodities available on the application (which are updated from the server). The application provides mandi rates from 3000 mandis across India, covering more than 500 commodities.	Accessible all over India	Free of cost
19.	MAHAAGRI SMS (http://www.mahaagrisms.com/)	Department of Agriculture, Government of Maharashtra (Public)	CDMA and GSM	2009	Push based SMS service	SMS can be sent to the farmers by Block/ Taluka Agriculture officer, Sub Divisional Agriculture Officer, Dist. Superintending Agriculture Officer, Divisional Joint Director,	Registered farmers of Maharashtra	Service is free of cost

(*Contd.*)

Sl. No.	Mobile Service	Service Provider	Network	Year	Working Mechanism	Nature and type of Agro-Advisory Services	Target User	Business Model
						Director Agriculture, Commissioner Agriculture, Secretary Agriculture and scientists from State Agriculture Universities; Location specific advisory service is provided by IMD		
20.	Life Tools (http://www.nokia.com/in-en/support/faq/)	Nokia and Idea Cellular(Private)	VAS from both GSM and CDMA	2009	Nokia life Tools is software embedded in certain Nokia phones to provide agricultural information services to the farmers.	Information on seeds, fertilizer and pesticide dosage, weather forecasting and commodity prices in Marathi and Hindi.	Can be accessed by anyone from anywhere in the country in 11 regional languages	Information available at Rs. 30 per month
21.	Mobile Multimedia Agriculture Advisory System (MAAS) (http://agritech.tnau.ac.in/govt_schemes_services/aas/profile.html)	TNAU, NAF, EPFPCL, DPFASL and IIT-M and sponsored by ICAR-NAIP (Public & private)	GSM and CDMA	2009	Pull based service through SMS and IVRS	Provides multimedia agri-advisory through GPS and GIS; the system does not develop any agricultural information but helps the farmers to get in touch with agricultural experts.	Registered farmers of three districts of Tamil Nadu	Free of cost service

(*Contd.*)

Sl. No.	Mobile Service	Service Provider	Network	Year	Working Mechanism	Nature and type of Agro-Advisory Services	Target User	Business Model
22.	KRIBHCO Reliance Kisan Limited (http://www.rcom.co.in/rcom/StoreLocator/press_release_detail.jsp?id=335)	Krishak Bharati Cooperative Ltd. and Reliance Communications Ltd. (Private)	GSM and CDMA	2009	-	-	-	-
23.	Awaaz De (Give your voice/ Voice porch) (http://awaaz.de/about-us/)	Awaaz De Info-systems Private Limitedsystems Private Limited	Software platform accessible over a unique dedicated phone number	2010	Mobile-web interface to create, browse and share voice messages. Interactive voice response systems (IVR), SMS, and the web to create seamless voice messaging groups connected over mobile phones. Users can create, disseminate and browse voice messages.	Awaaz De solutions used by Development Support Centre (an NGO), Gujarat working on issues of natural resources management, agricultural productivity enhancement and rural advocacy. -Digital Green and PRADAN are using Awaaz. De in Madya Pradesh to offer UNNATI Kisan Seva (The UNNATI	Marginal and small farmers	Free service to farmers. But, standard calling rates apply for users. However, clients (user organizations) need pay for Awaaze.De hosting charges.

(*Contd.*)

Sl. No.	Mobile Service	Service Provider	Network	Year	Working Mechanism	Nature and type of Agro-Advisory Services	Target User	Business Model
						Co-operative Farmers Service) which supports and connects their network of field workers. -Jatan Trust in Gujarat is using Awaaz.De to offer Sajiv Kheti Samvaad (Organic Farming Helpline) to teach and create awareness on basics about organic farming, answer questions and connecting local organic product buyers (http://awaaz.de).		
24.	Kisan Mobile Advisory Service (KMAS)	KVKs of ICAR (Public and private)	GSM	2010	Farmers receive SMS. Mostly push based agro-advisory	Based on the cropping season and major crops of the area, SMS is sent	Farmers from respective districts.	Free service to the farmers by the KVKs

(*Contd.*)

Sl. No.	Mobile Service	Service Provider	Network	Year	Working Mechanism	Nature and type of Agro-Advisory Services	Target User	Business Model
	(http://www.icar.org.in/node/1238)				services.	to the farmers in local dialect on the package of practices, varietal selection, dosage of chemicals used, pest and diseases management, weather information *etc.*		
25.	Market Price on Mobile (http://rubberboard.org.in/)	Rubber Board of India (Public)	GSM	2010	SMS and IVRS facility by dialing a specific number	Market prices of natural rubber in domestic and international market by SMS.	Rubber farmers and dealers in India. SMS services accessible all over India.	Subscription based service (Annual subscription fee Rs. 300).
26.	v-KVK	ICAR, IIT-K and ZPD Zone IV		2010	SMS, IVRS and web based service; push and pull based	SMSs and voice based advisory	Selected districts of Uttar Pradesh, Uttarakhand and Karnataka	Free of cost service
27.	Mandi on Mobile /Digital Mandi (http://digitalmandi.iitk.ac.in/)	BSNL tied up with state Govts. and IIT Kanpur (Public)	GSM	2011	SMS and IVRS facility by dialing a specific number	Market rate of vegetable, grain, pulse or fruit on software that work on voice command. To access, user needs to call up a specified BSNL	Farmers of Uttar Pradesh and Himachal Pradesh	Free of cost service

(*Contd.*)

Sl. No.	Mobile Service	Service Provider	Network	Year	Working Mechanism	Nature and type of Agro-Advisory Services	Target User	Business Model
						number. Voice based service to the farmers		
28.	mKisan (http://direct2farm.wordpress.com/category/projects/mkisan-projects/)	ILRI, CABI, Digital Green, CGMA and Handygo (Public and private))	Mobiles, Landlines	2011	Voice messages, text messages, on-demand videos, and a Farmer Helpline	The project will provide daily bulletins on agro-meteorology, crop pest and livestock diseases outbreaks, market information, and information on local service provision sources and information access to women farmers	Farmers of Utter Pradesh, Bihar, Madhya Pradesh, Maharashtra, Andhra Pradesh and Karnataka	Free of cost service
29.	SMS Service (http://agriharyana.nic.in/ext_aio.htm)	Dept. of Agril., Govt. of Haryana (Public)	GSM	2011	Both push and pull based service	Queries on all aspects of agriculture can be sent on a specific number	Accessible to farmers of Haryana	Free SMS service by Govt. of Haryana
30.	Annapurna Krishi Prasaar Seva (http://www.medialabasia.in/index.php/gallery)	Media Lab Asia, ICAR-NAIP, ANGRAU (KVK-Nalgonda and KVK-Nellore) (Public)	GSM	2012	Integration of mobile, web and IVRS by dialing a specific number	Mobile, Web and IVRS platform for farmer-specific agro-advisory services through voice, text and multimedia.	600 farmers from 6 villages in Nalgonda and Nellore districts of Andhra Pradesh	Free of cost service

(*Contd.*)

Sl. No.	Mobile Service	Service Provider	Network	Year	Working Mechanism	Nature and type of Agro-Advisory Services	Target User	Business Model
31.	Behtar Zindagi (Better life) (http://handygo.com/handy/NewSite/rural.html)	Handygo (Private)	Push and pull based SMS service	2012	IVRS on Mobile to deliver voice messages. Farmers and others can access information by dialing toll free number.	Package of practices in Agriculture, free Commodity Prices (Mandi rate), Weather Forecast & Agro-met advisory, Advisory for Fisherman & management of Inland Fisheries, Information on managing Livestock, Advise on women & child Health, HIV & STDs and towards reducing mortality rate, Rural Finance & ongoing Govt. schemes, Education & Self employment options in rural sector.	Farmers of South and Central India	Subscription based service (Rs. 30 for 30 days)
32.	Kisan Help Line (http://bausabour.ac.in/index.php/site/page/kisanhelpline)	Bihar Agricultural University (Public)	Mobiles, landlines, *etc*.	2012	Pull based service	Queries related to farmer's field and crops are answered	Farmers of Bihar	Free of cost service

(*Contd.*)

Sl. No.	Mobile Service	Service Provider	Network	Year	Working Mechanism	Nature and type of Agro-Advisory Services	Target User	Business Model
33.	m4agriNEI (http://www.m4agrinei.net/ http://www.m4agrinei.in)	Media Lab Asia (MoC&IT) & CAU, Barapani, Meghalaya (Public)	GSM	2012	Integration of mobile, web and IVRS by dialing a specific number	Mobile, Web and IVRS platform for farmer-specific agro-advisory services through voice, text and multimedia.	5000 farmers from Ri-Bhoi and East Khasi Hills district of Meghalaya	Service is free of cost.
34.	mFMS (http://mfms.nic.in/)	Department of Fertilizers, Government of India (Public)	Mobile application	2012	Web application with integration of Web, mobile and IVRS and mobile application for Java/Android mobiles	The application helps monitor the movement of the fertilizer from the manufacturer to warehouse to wholesalers and from wholesalers to retailers. The system will also act as a tool for Government Bodies to track and ensure the timely distribution of fertilizers to the farmers	Farmers and Govt. officials all over the country	The app can be downloaded free of cost from mFMS website
35.	SMS Weather Alert (http://www.	IMD & other mobile service providers (RML, Handygo,	GSM	2012	SMS alerts	Weather related information and forecasting	-All over India where RML, IKSL, Handygo and	As charged by the service providers

(*Contd.*)

Sl. No.	Mobile Service	Service Provider	Network	Year	Working Mechanism	Nature and type of Agro-Advisory Services	Target User	Business Model
	imd.gov.in/)	IKSL, Nokia and State Govt. of Maharashtra) (Public and private)					Nokia services are available. -Farmers of Maharashtra can access the service	
36.	Intelligent Advisory System for Farmers (IASF) (http://iasf.cdacmumbai.in/ias/)	C-DAC, DIT, GoI, Mumbai; Dept. Of Agriculture, GOvt. of Meghalaya, Dept. of Agriculture, Govt. of Manipur; KVKs of Meghalaya and CAU, Imphal (Public)		2013	SMS and call based service	Queries related to farmer's field and crops are answered	Accessible to farmers of Meghalaya and Manipur, agriculture experts and students	Free of cost service
37.	Kissan SMS Portal (http://www.farmer.gov.in)	Govt. of India (Public)	CDMA and GSM	2013	Push based SMS service	SMS regarding weather forecast, weather alerts, advisories on out break of disease/ pests of plants and animals, crop advisories on appropriate	Any farmers registered with state Govt. in any state of the country	Service is free of cost

(*Contd.*)

Sl. No.	Mobile Service	Service Provider	Network	Year	Working Mechanism	Nature and type of Agro-Advisory Services	Target User	Business Model
						technologies suited to local situations, etc., advisories on new or most suitable crop variety/ animal breed, market information, information on schemes and programs of Government of India and soil test results will be delivered through SMS		
38.	aAqua.mini (redesigned for mobile browser) (http://agrocom.co.in/products.php)	Agrocom (Private)	GSM and CDMA		SMS and IVRS based services	Localized remote crop diagnostic solution, audi prompted guide application in English, Marathi and Hindi, remote crop and land based diagnostics, microclimate, SMS enabled register and query mechanism.	Registered users of the country	Free of cost service
39.	ISAP-QRS (http://www.isapindia.org/static/Services.aspx)	ISAP and OWSA & CISCO (Private)	Mobiles, landlines		Based on IVRS system	Solutions to farmers' queries pertaining to agricultural practices, problems, productivity	Farmers of Himachal Pradesh, Madya Pradesh and Uttar Pradesh	Free of cost service

(*Contd.*)

Sl. No.	Mobile Service	Service Provider	Network	Year	Working Mechanism	Nature and type of Agro-Advisory Services	Target User	Business Model
						improvement, scientific farming and improved technology for production.	states of India.	
40.	Mrittika (http://www.ekutirsb.com)	Grameen Intel Social Business Limited and eKutir Social Business (Private)	Mobile application		Mobile phone and web based online/ offline application	The app recommends specific fertilizers and application amounts along with proper application method, source of fertilizer availability and cost estimation based on the type of crop, soil type, size of the land, planting season, and irrigation access	Farmers of Eastern India	Mrittika is licensed to loca entrepreneurs who pay a onetime fee of Rs. 600. Amount paid by farmers is determined by individual entrepreneurs
41.	Mobile based Crop Nutrient Management Decision Support System	Ekgaon Technologies and Farmers Federation (Private)			SMS and IVRS by mobile phone.	Based on farmers field and crop data, SMS/ voice alerts delivered to registered farmers. Crop cultivation with nutrient management advice during the cropping season.	Farmers of Nagapattinam district of Tamil Nadu.	Free service to the farmers

(*Contd.*)

Sl. No.	Mobile Service	Service Provider	Network	Year	Working Mechanism	Nature and type of Agro-Advisory Services	Target User	Business Model
42.	VedioKheti (http://research.microsoft.com/apps/video/dl.aspx?id=192973)	Microsoft Research India and Digital Green (Private)	Mobile application		Application with dedicated icons	147 videos available in the application for 22 crops classified and organized in four levels according to their content: crop, crop cycle, type of action, and type of method. The four levels are organised in a navigation tree for easier user interface. It uses SALAAM Automatic Speech Recogniser (ASR) to create a multi modal interface with speech, touch and graphics	Any farmer or agri. experts with a mobile phone supporting the application	Free of cost service
43.	Soil Based Plant Nutrient Management Information System (http://www.keralasoilfertility.net/pages/farmer_sample_details.jsp)	Department of Agriculture, Govt. of Kerala and IIITM-K (Public)	-		Push based SMS and voice calls	Soil nutrient advisory is delivered to registered farmers in local language	Farmers of Kerala	Free of cost service

Table 2. Categorization of the mobile based agro-advisory services based on the type of service provider

Sl. No.	Mobile service	Year	Service provider		
			Public	Private	Public and private collaboration
1.	Hello Uttam	2000		√	
2.	Via SMS	2000		√	
3.	Kisan Call Centre	2004			√
4.	Lifelines of India	2006		√	
5.	Warana Unwired	2006		√	
6.	Fisher Friend	2007		√	
7.	IFFCO Kisan Sanchar Limited (IKSL)	2007		√	
8.	Reuters Market Light	2007		√	
9.	DMI (Dynamic Market Information)	2008			√
10.	Fasal	2008		√	
11.	KHETI	2008		√	
12.	Kisan Sanchar	2008			√
13.	Nano Ganesh	2008		√	
14.	SMS Broadcast Service	2008	√		
15.	Avaaj Otalo (Voikiosk/ Spokenweb)	2009		√	
16.	Kissan Kerala	2009	√		
17.	mKRISHI	2009		√	
18.	Mandi Bhav	2009			√
19.	MAHAAGRI SMS	2009	√		
20.	Life Tools	2009		√	
21.	Mobile Multimedia Agriculture Advisory System (MAAS)	2009			√
22.	KRIBHCO Reliance Kisan Limited	2009		√	
23.	Awaaz De (Give your voice)	2010		√	
24.	Kisan Mobile Advisory Service (KMAS)	2010			√
25.	Market Price on Mobile	2010	√		
26.	v-KVK	2010	√		
27.	Mandi on Mobile/ Digital Mandi	2011	√		
28.	mKisan	2011		√	
29.	SMS Service	2011	√		
30.	Annapurna Krishi Prasaar Seva	2012	√		
31.	Behtar Zindagi (Better life)	2012		√	
32.	Kisan Help Line	2012	√		
33.	m4agriNEI	2012	√		
34.	mFMS	2012	√		
35.	SMS Weather Alert	2012	√		
36.	Intelligent Advisory System for Farmers (IASF)	2013	√		
37.	Kissan SMS Portal	2013	√		
38.	aAqua mini (redesigned for mobile browser)			√	
39.	ISAP-QRS			√	
40.	Mrittika			√	
41.	Mobile based Crop Nutrient Management Decision Support System			√	
42.	VedioKheti			√	
43.	Soil Based Plant Nutrient Management Information System		√		

Table 3. Categorization of the mobile based agro advisory services based on mode of service

Sl. No.	Mobile service	Year SMS	Mode of service					
			IVRS	Pictures	Videos	Web interface	Software/ mobile app	All
1.	Hello Uttam	2000		√				
2.	Via SMS	2000	√					
3.	Kisan Call Centre	2004		√				
4.	Lifelines of India	2006		√			√	
5.	Warana Unwired	2006	√					
6.	Fisher Friend	2007						√
7.	IFFCO Kisan Sanchar Limited (IKSL)	2007	√	√				
8.	Reuters Market Light	2007	√					
9.	DMI (Dynamic Market Information)	2008	√				√	
10.	Fasal	2008	√					
11.	KHETI	2008	√	√			√	
12.	Kisan Sanchar	2008	√					
13.	Nano Ganesh	2008						√
14.	SMS Broadcast Service	2008	√					
15.	Avaaj Otalo (Voikiosk/ Spokenweb)	2009		√			√	
16.	Kissan Kerala	2009	√	√				
17.	mKRISHI	2009	√	√			√	
18.	Mandi Bhav	2009	√					
19.	MAHAAGRI SMS	2009	√					
20.	Life Tools	2009	√					
21.	Mobile Multimedia Agriculture Advisory System (MAAS)	2009	√	√				
22.	KRIBHCO Reliance Kisan Limited	2009						
23.	Awaaz De (Give your voice)	2010	√	√			√	
24.	Kisan Mobile Advisory Service (KMAS)	2010	√					
25.	Market Price on Mobile	2010	√					

Sl. No.	Mobile service	Year SMS	Mode of service					
			IVRS	Pictures	Videos	Web interface	Software/ mobile app	All
26.	v-KVK	2010	√	√			√	
27.	Mandi on Mobile/ Digital Mandi	2011	√					
28.	mKisan	2011	√	√		√		
29.	SMS Service	2011	√					
30.	Annapurna Krishi Prasaar Seva	2012	√	√	√	√	√	√
31.	Behtar Zindagi (Better life)	2012	√					
32.	Kisan Help Line	2012		√				
33.	m4agriNEI	2012	√	√	√	√	√	√
34.	mFMS	2012	√					
35.	SMS Weather Alert	2012	√					
36.	Intelligent Advisory System for Farmers (IASF)	2013	√	√				
37.	Kissan SMS Portal	2013	√					
38.	aAqua mini (redesigned for mobile browser)		√				√	
39.	ISAP-QRS			√				
40.	Mrittika							√
41.	Mobile based Crop Nutrient Management Decision Support System		√	√				
42.	VedioKheti							√
43.	Soil Based Plant Nutrient Management Information System			√				

Table 4. Categorization of Mobile based agro-advisory services based on content

Sl. No.	Mobile service	Year Crop information	Content			
			Market	Weather	Holistic	Other
1.	Hello Uttam	2000	√	√		
2.	Via SMS	2000	√	√		
3.	Kisan Call Centre	2004	√			
4.	Lifelines of India	2006	√			
5.	Warana Unwired	2006	√		√	
6.	Fisher Friend	2007		√	√	
7.	IFFCO Kisan Sanchar Limited (IKSL)	2007				√
8.	Reuters Market Light	2007		√		
9.	DMI (Dynamic Market Information)	2008		√		
10.	Fasal	2008				√
11.	KHETI	2008	√			
12.	Kisan Sanchar	2008	√			
13.	Nano Ganesh	2008				√
14.	SMS Broadcast Service	2008				√
15.	Avaaj Otalo (Voikiosk/ Spokenweb)	2009				√
16.	Kissan Kerala	2009				√
17.	mKRISHI	2009				√
18.	Mandi Bhav	2009		√		
19.	MAHAAGRI SMS	2009				√
20.	Life Tools	2009				√
21.	Mobile Multimedia Agriculture Advisory System (MAAS)	2009	√			
22.	KRIBHCO Reliance Kisan Limited	2009				
23.	Awaaz De (Give your voice)	2010	√			
24.	Kisan Mobile Advisory Service (KMAS)	2010				√
25.	Market Price on Mobile	2010		√		
26.	v-KVK	2010				√

Sl. No.	Mobile service	Year Crop information	Content			
			Market	Weather	Holistic	Other
27.	Mandi on Mobile/ Digital Mandi	2011		“		
28.	mKisan	2011				√
29.	SMS Service	2011				√
30.	Annapurna Krishi Prasaar Seva	2012	√	√	√	√
31.	Behtar Zindagi (Better life)	2012				√
32.	Kisan Help Line	2012	√			
33.	m4agriNEI	2012	√	√	√	√
34.	mFMS	2012				
35.	SMS Weather Alert	2012			√	
36.	Intelligent Advisory System for Farmers (IASF)	2013				√
37.	Kissan SMS Portal	2013				√
38.	aAqua mini (redesigned for mobile browser)					√
39.	ISAP-QRS					
40.	Mrittika					√
41.	Mobile based Crop Nutrient Management Decision Support System		√			
42.	VedioKheti		√			
43.	Soil Based Plant Nutrient Management Information System					√

Table 5. Categorization of Mobile based agro-advisory services based on Business model

Sl. No.	Mobile service	Year	Business model	
			Free of cost	Service charge required
1.	Hello Uttam	2000	“	
2.	Via SMS	2000	“	
3.	Kisan Call Centre	2004	“	
4.	Lifelines of India	2006	“	
5.	Warana Unwired	2006		
6.	Fisher Friend	2007		“
7.	IFFCO Kisan Sanchar Limited (IKSL)	2007	“	
8.	Reuters Market Light	2007		“
9.	DMI (Dynamic Market Information)	2008	“	
10.	Fasal	2008	“	
11.	KHETI	2008	“	
12.	Kisan Sanchar	2008	“	
13.	Nano Ganesh	2008		
14.	SMS Broadcast Service	2008		“
15.	Avaaj Otalo (Voikiosk/ Spokenweb)	2009	“	
16.	Kissan Kerala	2009	“	
17.	mKRISHI	2009	“	
18.	Mandi Bhav	2009	“	
19.	MAHAAGRI SMS	2009	“	
20.	Life Tools	2009		“
21.	Mobile Multimedia Agriculture Advisory System (MAAS)	2009	“	
22.	KRIBHCO Reliance Kisan Limited	2009		
23.	Awaaz De (Give your voice)	2010	“	
24.	Kisan Mobile Advisory Service (KMAS)	2010	“	
25.	Market Price on Mobile	2010		“
26.	v-KVK	2010	“	
27.	Mandi on Mobile/ Digital Mandi	2011	“	
28.	mKisan	2011	“	
29.	SMS Service	2011	“	
30.	Annapurna Krishi Prasaar Seva	2012	“	
31.	Behtar Zindagi (Better life)	2012	“	
32.	Kisan Help Line	2012		“
33.	m4agriNEI	2012	“	
34.	mFMS	2012	“	
35.	SMS Weather Alert	2012	“	“
36.	Intelligent Advisory System for Farmers (IASF)	2013	“	
37.	Kissan SMS Portal	2013	“	
38.	aAqua mini (redesigned for mobile browser)		“	
39.	ISAP-QRS		“	
40.	Mrittika			“
41.	Mobile based Crop Nutrient Management Decision Support System		“	
42.	VedioKheti		“	
43.	Soil Based Plant Nutrient Management Information Sys.		“	

Table 6. Categorization of mobile based agro-advisory services based on target users

Sl. No.	Mobile service	Year	Target users	
			Country wide	Regional
1.	Hello Uttam	2000		"
2.	Via SMS	2000		"
3.	Kisan Call Centre	2004	"	
4.	Lifelines of India	2006		"
5.	Warana Unwired	2006		"
6.	Fisher Friend	2007		"
7.	IFFCO Kisan Sanchar Limited (IKSL)	2007		"
8.	Reuters Market Light	2007		"
9.	DMI (Dynamic Market Information)	2008		"
10.	Fasal	2008		"
11.	KHETI	2008		"
12.	Kisan Sanchar	2008		"
13.	Nano Ganesh	2008		"
14.	SMS Broadcast Service	2008	"	
15.	Avaaj Otalo (Voikiosk/ Spokenweb)	2009		"
16.	Kissan Kerala	2009		"
17.	mKRISHI	2009		"
18.	Mandi Bhav	2009		"
19.	MAHAAGRI SMS	2009		"
20.	Life Tools	2009		"
21.	Mobile Multimedia Agriculture Advisory System (MAAS)	2009		"
22.	KRIBHCO Reliance Kisan Limited	2009		"
23.	Awaaz De (Give your voice)	2010		"
24.	Kisan Mobile Advisory Service (KMAS)	2010		"
25.	Market Price on Mobile	2010	"	
26.	v-KVK	2010		"
27.	Mandi on Mobile/ Digital Mandi	2011		"
28.	mKisan	2011		"
29.	SMS Service	2011		"
30.	Annapurna Krishi Prasaar Seva	2012		"
31.	Behtar Zindagi (Better life)	2012		"
32.	Kisan Help Line	2012		"
33.	m4agriNEI	2012		"
34.	mFMS	2012	"	
35.	SMS Weather Alert	2012	"	
36.	Intelligent Advisory System for Farmers (IASF)	2013		"
37.	Kissan SMS Portal	2013	"	
38.	aAqua mini (redesigned for mobile browser)		"	
39.	ISAP-QRS			"
40.	Mrittika			"
41.	Mobile based Crop Nutrient Management Decision Support System			"
42.	VedioKheti			"
43.	Soil Based Plant Nutrient Management Information System			"

mobile use behaviour and impact of on-going projects to be carried out to understand the real benefits of mobile based agricultural advisory services. To say mobiles are going to revolutionise agricultural extension might be overstating the facts right now, but so far, within a few years of its introduction in the country, it has changed the mode of agricultural extension and has proved to be a great aid to the human resource of the extension system. It has added personal touch to the machines through voice calls, made understanding easier through pictures and videos and instant communication with agricultural experts anytime anywhere a reality through mobile communications. All that is needed is to learn from the success and failures alike and make mobiles an integral part of agricultural extension as it has become an integral part of the life of the people.

References

Addom, Benjamin Kwasi, (2011). Reforming Ag. Extension, One ICT at a Time. *http://agriculture.gbiportal.net/2011/11/01/reforming-ag-extension-one-ict-at-a-time/*

Alawode, Oluyinka, (2011). When Mobile Phones Unite Farmers, Consumers. *http://www.businessdayonline.com/NG/index.php/markets/agric-business/20394—when-mobile-phones-unite-farmers-consumers* (Accessed on 5th June, 2011).

Anandaraja, N., Sriram, N., Kathiresan, C., Shibi Sebastian and Vadivel, E., (2011). Linking the Farmers with Market through Web and Mobile. In: Saravanan, R., Kathiresan, C., and Indradevi, T., (Eds). *Information and Communication Technology for Agriculture and Rural Development*, New India Publishing Agency, New Delhi.

Annual Report, KVK South Tripura, (2013). Activities of KVK South Tripura (2012-2013), *Annual Report.* http://www.kvksouthtripura.org.in/News%20Article/KVK_South%20Tripura%20 Annual%20 Report%202012-13%20for%20ICAR_Tripura%20Centre.pdf (Accessed on 6th August, 2013).

Annual Report, ZPD-VIII, (2009-10). Zonal Project Directorate- Zone VIII, Bangalore, *Annual Report.* (http://zpdviii.gov.in/ZPD%20VIII%20Annual%20Report%202009-10.pdf).

Anurag, T.S., and Shambhukumar, (2012). Interactive Information Dissemination System: Architecture for Disseminating Information to Farmers. Information Technology in Developing Countries- *News Letter of the IFIP*, Vol. 22(2), July, 2012 issue. http://www.iimahd.ernet.in/egov/ifip/wg.htm

Bhaskar, G., (2013). Mobile SMS Application in Agricultural Information Dissemination: A Case on KVK, Bhabaleshwar SMS Alerts, *Reading Material,* Training Program on Application of ICTs in Modified Extension Reforms, National Institute of Agricultural Extension Management (MANAGE), Hyderabad.

Bhavnani, Asheeta, Chiu, Rowena Won-Wai, Janakiram, Subramaniam and Silarszky, Peter, (2008). The Role of Mobile Phones in Sustainable Rural Poverty Reduction, ICT Policy Division, Global Information and Communications Department (GICT), The World Bank. *http://siteresources.worldbank.org/EXTINFORMATIONANDC OMMUNICATION AND TECHNOLOGIES/Resources/The_Role_ of_Mobile_ Phones_in_ Sustainable_ Rural_ Poverty_Reduction_June_2008.pdf* (Accessed on 29th November, 2011).

Blom, Jan, (2009). Nokia Life Tools, Nokia, India -m-Serving Indian Agriculture. *I4d Magazine*, Vol. 7 (2), February, 2009, www.i4donline.net

Census of India, **(**2011**).** Mode of Communication: 2001-2011. Office of the Registrar General and Census Commissionar, India. Ministry of Home Affairs, Govt. of India, New Delhi,

India. *http://www.censusindia.gov.in* (Accessed on 21st November, 2012).

Cole, Shawn A and Fernando, A. Nilesh, (2012). The Value of Advice: Evidence from Mobile Phone-based Agricultural Extension.*http://www.dartmouth.edu/~neudc2012/docs/paper_251.pdf* (Accessed on 3rd August, 2013).

Colle, D. Royal, (2011). Book Review on ICTs for Agricultural Extension: Global Experiments, Innovations and Experiences, (Ed) R. Saravanan (2010). *Journal of Development Communication*, Vol. 22, No. 1. http://www.questia.com/library/1G1-279462004/r-saravanan-ed-icts-for-agricultural-extension.

Cuendet, Sebastien, Medhi, Indrani, Bali, Kalika and Cutrell, Edward, (2013). VideoKheti: Making Video Content Accessible to Low Literate and Novice Users. *http://research.microsoft.com/pubs/183489/Cuendet-CHI2013-VideoKheti-Final.pdf* (Accessed on 5th August, 2013).

Dearden, Andy, Matthews, P. and Rizvi, Haider, S.M., (2012). Kheti: Mobile Multimedia in an Agricultural Co-operative. *Personal and Ubiquitous Computing* (In Press). Available from Sheffield Hallam University Research Archive (SHURA) at: http://shura.shu.ac.uk/2890/1/DeardenMatthewsRizviFinal2_(2).pdf (Accessed on 12th January, 2012).

Dileepkumar, G., (2012). ICT Innovations for Agriculture and Rural Development. *Presented in the 8th Convention of Grameen Gyan Abhiyan-Rural Knowledge Movement*, Role of ICT in Rural Transformation, M.S. Swaminathan Research Foundation, Chennai, October 28-29th, 2012. www.mission2007.in/8th_Covention/pdf/Session-3/MSSRF/Dileep.pdf

DoA, GoM., (2013). MAHAAGRI SMS, Department of Agriculture, Government of Maharashtra).*http://www.mahaagrisms.com/default.aspx? Aspx Auto Detect Cookie Support=1* (Accessed on 6th August, 2013).

Fafchamps, Marcel and Minten, Bart. (2012). Impact of SMS based Agricultural Information on Indian Farmers, *The World Bank Economic Review*, Published by the Oxford University Press on behalf of the International Bank for Reconstruction and Development. 1-32. http://wber.oxfordjournals.org/content/early/2012/02/27/wber.lhr056.full.pdf+html

Fautrel, Vincent, (2011). Lessons from Market Info Systems Experiences in Africa. *Presented in the CARICOM Workshop on Regional MIS*, Port-of-Spain, Trinidad (15-17 February, 2011).http://193.194.138.42/upload/SUC/MIS_Caribbean_Feb11/Tuesday/CTA_Experience_Africa_en.pdf

GMA News, (2011). Philippines - World's First Mobile App for Rice Production Unveiled, *http://www.flar.org/index.php/es/news/1130-philippines-worlds-first-mobile-app-for-rice-production-unveiled* (Accessed on 10th June, 2011).

Hanumankar, Hemnath Rao, (2011). Application of ICT in Agricultural Extension: An Evaluation Study of Kissan Call Centres (KCCs). In: Saravanan, R., Kathiresan, C., and Indra Devi, T., (Eds). *Information and Communication Technology for Agriculture and Rural Development*, New India Publishing Agency, New Delhi.

Hedge, Rajesh, (Unknown). Personalized Multi-Modal and Multi-lingual Agro Commodity Pricing System for the Indian Kisan.*http://www.w3cindia.in/HTML5_Compatability/session%204/w3ctalk_mar15.pdf* (Accessed on 3rd August, 2013).

IANS, (2008). Farmers to Get Market Rates on BSNL Mobiles. *http://www.thaindian.com/newsportal/business/farmers-to-get-market-rates-on-bsnl-mobiles_100116668.html* (Accessed on 5th July, 2009).

IASF, (2013). Intelligent Advisory System for Farmers. http://iasf.cdacmumbai.in/ias/index.jsp (Accessed on 5th August, 2013).

ICRISAT, (2012). Agropedia: The Knowledge and Interaction Hub for Indian Agriculture. *Information Bulletin on Agropedia. vasat.icrisat.org/images/New%20Folder/Agropedia.pdf* (Accessed on 12th January, 2012).

IFFCO. (2008). IFFCO, 2008. IFFCO and Airtel Join Hands to Usher in the Second Green Revolution. Joint venture company IFFCO Kisan Sanchar Ltd. to provide big boost to

Indian agriculture and rural economy. *http://www.iffco.nic.in/applications/ iffcowebr5.nsf/ 0/89b6f7f9c1950e3465257442003 ae142?OpenDocument* (Accessed on 5th July, 2009).

ILRI Project File, (2012). mKisan-Using Mobile Technologies to Strengthen Farmer-Extension-Expert-Linkages in India. *http://cgspace.cgiar.org/bitstream/handle/10568/24461/ mkisanMobileOct2012.pdf*

Jain, Sudhanshu, (2011). Behtar Zindagi – Empowering Rural Lives. *http://mgovworld.org/libra/ meducation/casestudies/201cbehtar-zindagi201d-2013-empowering-rural-lives* (Accessed on 4th November, 2011).

Judy Payne, (2010). ICT to Enhance Farm Extension Services in Africa. Briefing Paper by USAID's Fostering Agriculture Competitiveness Employing Information Communication Technologies (FACET) project. *https://communities.usaidallnet.gov/ictforag/file/10/ download* (Accessed on 29th November, 2011)

Kashem, M. Abul, (2011). Farmers' Use of Mobile Phones in Receiving Agricultural Information towards Agricultural Development.*109.73.162.110/.../Abul%20Kashem%20-...*(Accessed on 29th November, 2011).

Kdevries, (2006). Pallitathya Help-Line Center, The Communication Initiative Network. *http:// www.comminit.com/?q=global/node/132155* (Accessed on 1st December, 2011).

KVK, RVSKVV, (2012). KVK's brief achievement 2009-'10 to 2011-12. *http://www.rvskvv.nic.in/ Documents/DES/achievement_09-12.pdf* (Accessed on 6th August, 2013).

Lall, Anusha and Sahi, Swati., (2009). Taking ICTs to the Grassroots- A Case Study of the Lifelines India Initiative, *IFIP news letter*, 19 (1), www.iimahd.ernet.in/egov/ifip/ feb2009/ anusha-lall.htm (Accessed on 3rd July, 2009).

Manoranjan, Mohapatra, (2009). Value Added Services in Rural India. *Connect-World*, No. 26, India issue 2009. *http://www.comviva.com/media/Moa's_Article_VAS% 20in% 20rural%20India.pdf* (Accessed on 5th July, 2009).

Media Lab Asia, (2013). Interactive Information Dissemination System. *Brochure*. Published during the launching of Annapurna Krishi Prasaar Seva, NIRD, Hyderabad.

Mittal, Surabhi, (2012. Modern ICT for Agricultural Development and Risk Management in Smallholder Agriculture in India. *Socio-Economic Working Paper 3*, CIMMYT, Mexico.

Mittal, Surabhi, Gandhi, Sanjay and Tripathi, Gaurav, (2010). Socio-Economic Impact of Mobile Phones on Indian Agriculture. *ICRIER Working Paper No. 246*, Indian Council for Research on International Economic Relations (ICRIER), New Delhi.

MoA, GoI., (2013). State of Indian Agriculture 2012-13. Published by the Ministry of Agriculture, Department of Agriculture and Co-operation, Directorate of Economics and Statistics, New Delhi. *agricoop.nic.in/Annual report2012-13/ARE 2012-13/pdf*

Munyua, Hilda, (2008). ICTs and Small Scale Agriculture in Africa: A Scoping Study. The International Development Research Centre (IDRC), Canada. *web.idrc.ca/.../ 12415296931FInal_Rev_6[1].1.5_Scoping_Study__I...(Accessed on 29th November, 2011).*

Nenkari, Hedwig, Gakuru, Mucemi, Mulagoli, Isaac and Kabutha, Charity, (2010). National Agriculture and Livestock Extension Extension Services through Mobile Telephony and Internet. The National Farmers Information Service in Kenya. *www.iaald2010.agropolis.fr/ .../NENKARI-2010 Extension_services_through_Mobile_telephony_and_internet-IAALD-Congress-158.pdf*

News-i4d, (2007). Haryana Farmers Use SMS Service for Agricultural Problems. *http:// www.i4donline.net/news/news-details.asp?catid=1&newsid=8910* (Accessed on 5th July, 2009).

News-i4d, (2009). News-i4d, 2009. QUALCOMM Launches Fisher Friend to Empower Fishing Communities in India. http://www.i4donline.net/articles/current-article.asp? articleid=1392&typ=Features (Accessed on 5th July, 2009).

NSSO, (2005). Access to Modern Technology for Farming, Situation Assessment Survey of

Farmers. 59th Round. *Report No. 499*, National Sample Survey Organisation (NSSO), Ministry of Statistics and Programme Implementation, Government of India, New Delhi.

Okyere, Kwadwo Asenso and Ayalew, Daniel, (2011). Opportunities and Challenges for Using ICTs for Agricultural Extension and Advisory Services in Africa. *Presented in the International conference on Innovative Approaches for Agricultural Knowledge Management: Global Extension Experiences* (November 9-12, 2011), New Delhi, India.

Pande, Arun K., and Arve, Subhash, (2009). mKRISHI based Grape Farming. *I4d Magazine*, 7 (2), February, 2009. www.i4donline.net

Pande, Arun, Kimbahune, Sanjay, Singh Dinesh Kumar, Gupta, Ankita (2011). mKrishi: Facilitating Farmers in Enhancing Agricultural Production. *A compendium of Pioneering Initiatives in e-Agriculture in India and Around the World- Proceedings of the 14th National e-Governence Conference*, Aurangabad, India

PC, GoI. (2007). Recommendations of Working Group on Agricultural Extension for Formulation of Eleventh Five Year Plan (2007-12), Planning Commission, Government of India, New Delhi. http://planning commission.nic.in/plans/planrel/11thf.htm (Accessed on 10th November, 2011).

PC, GoI., (2011). Faster, Sustainable and More Inclusive Growth-An Approach to the Twelfth Five Year Plan (2012-17). Planning Commission, Government of India, October, 2011. *http://planningcommission.nic.in/plans/planrel/12appdrft/appraoch_12plan.pdf* (Accessed on 15t August, 2013).

PC, GoI., (2013). Twelfth Five Year Plan (2012–2017) Economic Sectors. Volume II, Planning Commission, Government of India, *http://planningcommission.nic.in/plans/planrel/12thplan/pdf/vol_2.pdf* (Accessed on 15t August, 2013).

PIB, (2013). Kissan SMS Portal: FAQs. *http://pib.nic.in/newsite/backgrounders.aspx?relid=97219* (Accessed on 6th August, 2013).

Raj, Daniel Anand, Poo Murugesan, A.V., Aditya, Vijay Pratap Singh, Olaganathan, S., Sasikumar, K., (2010). Crop Nutrient Management Decision Support System: India. *http://www.enrap.org/research/icts-for-livelihoods-research/icts-for-livelihoodsresearchpapers/Nutrient%20Management%20Decision%20Support %20System %20for%20Livelihood %20Security%20of%20Farmers.doc/view* (Accessed on 29th December,2010).

Raj, Daniel Anand, Poo Murugesan, A.V., Aditya, Vijay Pratap Singh, Olaganathan, S., Sasikumar, K., (2011). A Crop Nutrient Management Decision Support System: India.In: Grimshaw, David, J., and Kala, Shalini (Eds.). *Strengthing Rural Livelihoods-The impact of Information and Communication Technologies in Asia*. Practical Action Publishing Ltd. and IDRC, Ottawa.

Reliance, (2013). KRIBHCO and Reliance Communications Infrastructure forge Rural Marketing Joint Venture. *http://www.rcom.co.in/rcom/StoreLocator/press_release_detail.jsp?id=335* (Accessed on 5th August, 2013).

Rizvi, Haider, S.M., (2010). Sustainability of ICT Design Interventions in Agriculture with Poor-The Challenges and Way Forward (A Case Study based on the Application of Knowledge Help Extension Technology Initiative (KHETI) in India), *Abstract Volume of the AFITA 2010 International Conference on the Quality Information for Competitive Agriculture based Production System and Commerce*.http://repository.ipb.ac.id/bitstream/handle/123456789/41741/Sustainability%20of %20ICT%20 Design% 20Interventions% 20in%20Agriculture.pdf?sequence=1 (Accessed on 12th January, 2012).

Saravanan, R., (2010). *ICTs for Agricultural Extension: Global Experiments, Innovations and Experiences*. New India Publishing Agency, New Delhi.

Saravanan, R., (2011). ICTs for Agricultural Extension in India: Innovations, Lessons and Way forward. *Presented as an Invited panellist for the APAARI Session on Openness in Agricultural Information and Knowledge Sharing during the INSEE International*

Conference -2011 on "Innovative Approaches for Agricultural Knowledge Management: Global Extension Experiences" organised by the International Society of Extension Education, New Delhi, India.

Singh, Manmohan, (2011). ICAR-83rd Foundation Day Address. *ICAR press release*, dated 16th July, 2011, *www.icar.org.in* (Accessed on 7th August, 2011).

Soochna Se Samadhan, 2009. Soochna Se Samadhan -Knowledge Services Just on the Dial of Phone. *www.solutionexchange-un.net.in/decn/cr/res05110601.doc* (Accessed on 2nd July, 2009).

Sriram, N., Vadivel, E., Venkatachalam, R and Anandaraja, N., (2013). New ICT Tools for Mobile based Agro-Advisory Service System. *Paper presented during the ICAR sponsored summer school on information and communication technology, initiative for inclusive agricultural development* (July 3-23, 2013), Department of Agricultural Extension, TNAU, Coimbatore.

Suchiradipta, Bhattacharjee, (2012). Mobiles for Mobilizing Agricultural Extension in India. *M.Sc. Credit Seminar Report*, submitted to the School of Social Sciences, College of Post Graduate Studies, CAU, Umiam, Meghalaya.

Taz, (2010). Mobile pPhones are Improving Agriculture in Kenya*http://sciafrique.wordpress.com/2010/09/29/mobile-phones-are-improving-agriculture-in-kenya/* (Accessed on 7th June, 2011).

Telecominfo, (2009) Future Speculation of Mobile VAS in India. Telecominfo's Weblog. *http://telecominfo.wordpress.com/2009/01/22/future-speculation-of-mobile-vas-in-india/* Updated on January 22nd, 2012 (Accessed on November 21st, 2012).

The Financial Express, (2013). Tata Teleservices Launches New Service 'Mandi Bhav'. http://www.financialexpress.com/news/tata-teleservices-launches-new-service-mandi-bhav/413076/0 (Published on 20th January, 2009; Accessed on 5th August, 2013).

Tiwari, Rituraj, (2012). Government Ropes in IFFCO Kisan Sanchar Limited to Improve Kisan Call Centres. *The Economic Times.* http://articles.economictimes.indiatimes.com/2012-05-05/news/31586427_1_kccs-modern-agricultural-practices-advisory-service (Published on 5th May, 2012; Accessed on 12th August, 2013).

TNAU, (2013). Development of ICT based Tools/Technology towards an Interactive Multimedia Agriculture Advisory System.*http://agritech.tnau.ac.in/govt_schemes_services/aas/index.html* (Accessed on 6th August, 2013).

TRAI, (2013). Indian Telecom Services Performance Network. *Press Release*, January – March, 2013. (Telecom Regulatory Authority of India (TRAI). *http://www.trai.gov.in/WriteReadData/PressRealease/Document/PR-TSD-May13%2860%29.pdf* (Accessed on 30th August, 2013).

Veeraraghavan, Rajesh, Yashodhar, Naga and Toyama, Kentaro, (2009). Warana Unwired: Replacing PCs with Mobile Phones in a Rural Sugarcane Cooperative. I*nformation Technologies and International Development*, 5(1): 81-95.

Wikipedia, (2012). Telecommunications Statistics in India. *http://en.wikipedia.org/wiki/Telecommunications_Statistics_in_India*. Updated on November 22nd, 2012 (Accessed on November 28th, 2012).

www.fasal.intuit.com, (2013). Intuit Fasal. *http://fasal.intuit.com/index.html* (Accessed on 3rd August, 2013).

www.iasf.cdacmumbai.in, (2013). Intelligent Advisory System for Farmers. *http://iasf.cdacmumbai.in/ias/jsp/about.jsp* (Accessed on 5th August, 2013).

www.kissankerala.net, (2013). Kissan Kerala Mobile based Agricultural Information Services. *http://www.kissankerala.net/sms/index.jsp* (Accessed on 5th August, 2013).

More about this book:

http://www.saravananraj.net/books/

http://www.bookfactoryindia.com/index.php?p=sr&Uc=9789383305230