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Contemporary Information and Knowledge Management: Impact on Farming in India

R Ajith Kumar[1]
Indian Institute of Information Technology and Management, Kerala, India
ajithr@iiitmk.ac.in

V Balaji*
Commonwealth of Learning (COL), Canada
vbalaji@col.org

G Dileepkumar
Iowa State University, USA
dileep@iastate.edu

T V Prabhakar
Indian Institute of Technology Kanpur, India
tvp@iitk.ac.in

N T Yaduraju
International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India
n.yaduraju@cgiar.org

[1]: Authors are listed in the alphabetical order of surnames
*: corresponding author; with ICRISAT until Sep 2010

Abstract

Farming is an important part of Indian economy and it involves a wide range of stakeholders, of whom the small holder farmers are the largest group. Information sharing on new production processes with farmers was prominent in the 'sixties which was key to the success of the Green Revolution. Agricultural extension, the process of enabling farmers and experts to exchange information with each other, has since been institutionalized to a high degree and is assessed to be not as effective as it had been a generation back. The advent of digital, technology-mediated information and knowledge management was thought to offer significant new opportunities for knowledge exchange in Indian farming as a whole. These hopes led to the launching of a number of initiatives in different parts of India, which has emerged as the host of the largest number of rural development projects where contemporary information and communication technology (ICT) play a pivotal role. While analyzing the outputs of such initiatives, many studies have pointed out that farming is not a priority concern of most of them. On the other hand, we can notice a non-complimentary strand of ICT in agriculture projects operated by a number of institutions with ICT resources playing a key role in some of them. These efforts, generally speaking, do not promote user participation in information flows quite unlike the contemporary trends.

Almost two decades later, the original hope remains unfulfilled. The nation-wide availability of digital content in relation to the farming sector is small when compared to equally important development sectors such as public health. This has considerably limited the opportunities for various stakeholders to build viable online services on production, marketing and meteorology for farmers and other stakeholders. What we now have is a collection of projectized activities that are fragmented in their overall understanding and approaches. What we need is an approach that can bring together the two strands, namely, of ICT in rural development and ICT in agriculture. Such an effort, however, needs a new IT architecture to be developed for aggregation of content and to make services available in multiple modes. Two groups of projects in India, namely, the *Agropedia* and the *KISSAN-Kerala*, have built large prototypes and human capacities using unprecedented innovations in web technology areas and in integrated services delivery (including mobile telephony). With their advent, a wider range of solutions to the challenge of developing a novel architecture for information services for farming in India are now feasible and need to be researched upon. Countries that offered extension models for India in in an earlier generation do not require innovations for mass outreach for prosperity through farming and are thus in position to offer models for the present India needs to build solutions, processes and structures of its own so that the advantages accruing from its rapidly advancing ICT and mobile telephony infrastructure and export-oriented IT sector can flow to the benefit of its farmers. Formation of synergies with non-traditional partners such as those in ICT sector will be essential. There is a task to be accomplished, and it is contrary to the prevalent understanding in the leadership of farm education, research and extension sector that all the ICT solutions needed are available.

1. Introduction

Farming is perhaps the most important sector of Indian economy today, given the concerns over food price inflation. While dwelling on the spiraling impact of increased food prices on the national economy as a whole, commentators have pointed out that the continued neglect of agricultural extension, the process of linking farmers with institutionalized expertise, is one of the causes of emerging shortages in food production. This is where our story begins. (To emphasize smallholder farmers as key stakeholders in global and national food security, we will refer to agriculture as farming in this article).

For generations, agricultural extension has been recognized as an essential mechanism for enabling information and knowledge transfers among experts and farmers (Jones, 1997). It was not known when the first extension activities took place, but the birth of modern extension service has been attributed to the aftermath of Irish Famine (Jones & Garforth, 1997). The role of agricultural extension was very significant in the advancement of food cereals production in the Green Revolution era in India in the '60s and '70s. (AKM-India, n.d.). However, the original paradigm, primarily one of top-down, technology transfer arrangement, is no longer considered to be adequate or effective. Today, many extension models are in use to support the information needs of farm communities. Each model has its own concepts and practices, and advantages and disadvantages.

According to Carl Eicher (Carl, 2007), there are six extension models in use around the world. Among them 'the national public extension model' introduced by the U.S. Land Grant College system is the dominant extension model that is premised on the coordination and management of three interlinked processes: agricultural research, extension and agricultural higher education among the responsible institutions in the countries that have adopted this model. The transaction costs of the Land Grant Model are considered to be low. Governments in Malaysia, Mali and other countries exporting cotton or palm oil use 'the community extension and research model' that combines research and extension more directly. Turkey launched 'the training and visit (T&V) extension model' in the early 'seventies that spread to other parts of the world under the World Bank sponsorship in the late 'seventies and the 'eighties. Though the T&V model has proven to be financially unsustainable (Anderson et al., 2006), some of the countries still use modified T&V extension programs. Some other countries have tried out 'the farmer field school (FFS) model' that emerged in South East Asia in the 'eighties when extension workers offered advice to farmers on using IPM (Integrated Pest Management) to control pests in rice mono-cropping areas in the Philippines and Indonesia (Feder et al., 2004), (Anderson et al., 2006). Though there is spirited debate among extension experts whether the FFS is an approach or a model, the model proved to be effective in reducing pesticide use by up to 80 percent on farms in these two countries. The FFS model is now being used in around 50 developing countries (Carl, 2007). In recent years 'the private extension model' was introduced with an expectation that the adoption of the user-pays principle will offset some of the cost of extension so that tax-based outlays on extension would be reduced (Anderson et al., 2006). However there is little evidence to date that smallholder farmers can "buy their way out of poverty" by paying for extension advice. When some of the NGOs realized that the private extension models are far from the reach of small scale farmers in developing countries, they shifted gears from providers of food aid and humanitarian assistance, and this gave rise to 'the NGO extension model'. They started recruiting extension workers (for instance in Mozambique in 2005, the NGOs employed 840 extension workers as compared with 770 public extension workers (Gemo et al., 2005)).

Apart from these, there are some other country-specific models, that have become prominent in the recent years. An example is the ATMA Extension Model' initiated in late 'nineties in India with World Bank support (Singh et al., 2006) when the extension specialists realized the need for decentralized public extension systems. The Agriculture Technology Management Agency model (ATMA) combines decentralization with a focus on agricultural diversification and increasing farm incomes and employment; and collects feedback from clients to extension specialists, researchers, policy makers and donors. Based on the feedback, the decisions on extension are made by a locally-based governing board with equal representation between (1) the heads of the line departments, (including agriculture, animal husbandry, horticulture etc). and key people in the State Department of Agriculture; (2) research units within the districts and stakeholder representatives and (3) a cross-section of farmers, women, disadvantaged groups and the private sector (Anderson & Feder, 2007). Although there is no impact studies of this model have been published yet, it is known that this model has spread within India over agro-ecologically diverse regions.

Experts participating in the recent "Global Consultation meeting on revitalizing extension and rural advisory services" held at the Iowa State University, USA (12-13 October 2010) were of the view that extension today is in a state of decline in many countries. , The public extension system especially is inadequate in terms of both human and infrastructural resources. Grinding poverty and chronic hunger remain partially or substantially unmitigated in many regions of the world while new challenges, including climate change, water scarcity, and soil quality reduction have emerged. The challenges to achieving food self-sufficiency, accessibility and affordability dominate the development agenda. The solutions must be and knowledge- intensive, along with robust process design, scalability and monitoring, evaluation and assessment mechanisms built-in (Anon., n.d.) (Global Extension Community Cafe, n.d.). Many of the experts have come to believe that extension needs to be free from the narrow mindset of transferring technology packages. It should move towards a knowledge exchange mode that supports, innovations and decision-support for income and livelihood security and growth among extension clients, not just yield increases. The perspective for extension must be whole value chains or even value networks. Extension, as a paradigm, should evolve to become more effective in meeting the information needs of a much wider variety of clientele, including women farmers, agribusiness, rural youth, and the resource-poor farmers.

2. Farming, Extension and Internet in India

In the early days of Internet in India, much hope was raised about its potential to transform agricultural extension. For example, an international group of experts from both the developing and developed countries proposed a paradigm of "Computer-Aided Extension" (CAEx) along the lines of Computer-Aided Design or Manufacturing (CAD/CAM) (Swaminathan, 1993). Combination of desk-top multimedia and access to information networks, these experts surmised, would lead to an era where farmers could have access to key information on the 3 M's , namely, "Materials (such as seeds, fertilizers, pest/insecticides), Meteorology and Markets" which will help them overcome the usual hurdles in adopting new technologies for production and in finding the right prices and markets.

Since the late 'nineties, a number of pilot experiments are in progress in rural areas of India, using contemporary Information and Communication Technologies (ICT) especially the Internet, the web and its new platforms (Web 2.0 and social networking), and mobile telephony. A key arrangement in delivery of services through such projects is the existence of tele-centers. The estimates of such connected rural centers vary between 11000-14000. How have they contributed to the advancement of prosperity through farming in the last 15 years?

This set of statements attributed to the Indian Minister for Agriculture, Mr. Sharad Pawar, has an answer : http://www.indiatogether.org/2011/jan/agr-harvest.htm

Despite so many agriculture universities and research centers, why are our farm yields so low?

It is not correct to say that Indian agricultural yields are universally very low. In fact, Indian yields for wheat and rice in several states are quite comparable to the best in the world. Similar is the case with yields for fruits and vegetables in many states. However, since a large part of the country is still rain-fed, average yields in many crops tend to be lower. Why are our farmers so vulnerable?

This is on account of two primary factors. One relates to their small holdings that tie them in a low income trap, restraining any credible investment of their income or surplus in land productivity. Secondly, 60 per cent of agriculture is still dependent on the rains. If the rains fail or there are unfavorable variations in rain or other climatic factors, then crops suffer.

This is also the time when the spokespersons of the software industry in India forecast that in spite of continuing fiscal crisis in many OECD countries, over about 180 000 fresh hires would occur in 2011 in India. Disconnect between a thriving IT industry and the agrarian income and food production in the country has never been greater. The promise of ICT's and contemporary information management for at least the average Indian farmer is yet to be realized. Is this part of a bigger challenge affecting more countries?

3. Farming, Agriculture and the Web: a generic analysis

Back in 2008, a group of scholars in International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) conducted an analysis of agriculture-related entries in the popular Wikipedia, and found that there were less than 6000 entries in this very broad category when the total size of entries was about 1.3 million. Later in 2009, an agriculture portal on Wikipedia was launched. As of Jan 2011, a comparison of this portal and another in a domain such as health shows that it is still under populated. It is vastly so when compared with a sub portal in natural sciences such as biology! An entry on "high yielding variety", an important concept and practice in contemporary agriculture, at 523 words, is classified as one that is in need of improvement whereas the one on Boeing 787, just one type of airplane in a particular class of aircraft has an intricate contribution, quite unlike that on hybrid variety. More such examples can be given.

On the very popular *Facebook*, the *FarmVille* is considered to be the most-widely used application, with an estimated 62 million active users. However, this popularity of farming does not translate into support for improved farming. The *FarmVille* designers consider it as a social gaming activity, built on the "instinct" of people to nurture- in other words it has got nothing to do with supporting advancement of food production or the income of the resource-poor farmer! The YouTube space, famous for its emerging role as a "speaker's corner" has relatively fewer videos that directly relate to farming (a significant amount coming from KISSAN-Kerala which is covered in this article later), more relating to recipes and cooking. It is significant that no agricultural faculty in a land grant university in the USA or any agricultural university elsewhere figures among the YouTube universities.

There are a number of inter-governmental and international organizations in the agriculture sector which have sector-specific programs in information management, such as the UN

Food and Agriculture Organization (FAO) (FAO, n.d.) and the consortium of agricultural research centers known as the Consultative Group on International Agricultural Research (CGIAR) (CGIAR, n.d.) of which ICRISAT is a member. There are also major networking organizations such as the Global Forum for Agricultural Research (GFAR) (GFAR, n.d.) and their allied organizations in Africa, Asia and Latin America. The FAO, consistent with its character as a premier inter-governmental body in agriculture, has focused more on standards in agricultural information management and is in the process of building new online services in agricultural ontology (FAO, n.d.) (AGROVOC, n.d.). The FAO and GFAR have recently started to promote the CIARD (Coherence in Information in Agricultural Research and Development) (CIARD, n.d.) which also focuses on standards and training of relevant professionals. The CGIAR has a corporate program which is a non-technical advocacy group focusing more on intra-institutional matters with little interest or demonstrated capability in agricultural content matters (ICTKM, n.d.).

Globally, there is thus a serious gap in the presence or accessibility of digital information, especially on the Internet, relating to farming/agricultural sector. This limitation is somewhat unique since other primary and development-oriented sectors, such as health and medicine, are known to have larger amounts of information on which web-services can be built. An example here is the way an inter-governmental body such as the World Health Organization (WHO) used the Internet to track the spread of the Avian Flu pandemic using vast quantities of information and data available online (IVTM, n.d.). A corresponding effort to forecast adequately a major crop/animal disease or even a more easily noticed event such as large scale drought cannot be easily cited yet (a micro-level exception is at http://vasat.icrisat.org/?q=node/70- see also below). This inability is directly due to the relative paucity of content on agriculture and farming in the Internet space.

4. Digital Information Management and Farming in India

That the vision of benefits from digitalization of information services in agriculture, articulated by experts back in 1992 has remained unfulfilled for a long time after is evident from the reports of the Indian National Commission on Farmers (NCF) (National Commission on Farmers, 2004). In its first report, the NCF stated its vision for a Digital Gateway for Agrarian Prosperity in India as follows (National Commission on Farmers, 2004):

"The support system for a rural knowledge revolution should be complemented, by establishing a National Digital Gateway for Rural Livelihood Security. There is need for investment in creating databases relevant to rural needs. For example, a decade ago, a National Agricultural Drought Assessment and Monitoring System was set up under the National Remote Sensing Agency (NRSA) to facilitate improved decision making by farmers in the kharif and rabi seasons. The potential of this system needs to be harnessed for giving proactive advice to farm families on land and water use planning. The architecture of such a gateway should be based on currently available digital content from diverse agencies, ranging from the ICAR to the NRSA and ICRISAT, with a focus on improving livelihood security in rural India. Every participant agency should be encouraged to create well-adapted and annotated digital content (maps, numeric data or documents etc.) in a manner accessible to non-specialists".

In its final report released in 2006, the NCF stated again:

"The help of ICT should be harnessed by establishing a Gyan Choupal [village knowledge center] in every village. The Common Service Center (CSC) programme of the Department of Information Technology (DIT), Government of India, should aim at social inclusion in the use of this important technology. The structure of the ICT based knowledge system will be as follows:

- Block level: Village Resource Centre (VRC) established with the help of the Indian Space Research Organisation.
- Village level: Gyan Choupals established with the help of the CSC Programme of the DIT.
- Last mile and the last person connectivity: This can be accomplished through either internet – community radio or internet – mobile phone synergy".

During the last fifteen years, a large number of e-Governance projects have been launched in different parts of the country, some receiving international recognition in initial stages. An earlier analysis (Keniston et al., 2005) showed that agricultural extension support had not been a priority in general in the e-Governance projects.

A significant study that emerged at this time was the one by the National Sample Survey Organization (NSSO) which had conducted a well-organised survey covering over 50 000 farmer households across India, focusing on the information exchange habits and patterns among farmers of every type in nearly every agro-ecological region of India (NSSO, 2005). This study offered numerous insights, showing clearly that the availability of Internet infrastructure in India from 1995 onwards had not made a difference to the typical farmer. Nearly half of all information transactions in relation to farm production remained informal, mostly between farmer to farmer; in the locality, the transactions reached the local input supplier/dealer and the money lender and with little exchange taking place trans-locality.

The exchanges of farmers with India's famed Farm Science Centers, the Krishi Vigyan Kendra's (KVK's) (Anon., n.d.) were significantly limited, as revealed in this survey. (It is also significant that even as of close of 2010, fewer than 20 of these 600-odd centers had a presence on the Web, while about a third of them have been connected digitally in a closed user group configuration).). The NSSO report confirms a trend noticed and reported from two different locations in India in 1999 and 2003 (Balaji et al., 2003) (VASAT, 2003). Both these previous surveys on information exchange patterns in rural Pondicherry and Mahbubnagar region of Andhra Pradesh revealed that farmers predominantly were obtaining production-related information from other farmers who may have been in the same economic situation. There is evidently a serious gap between practicing farmers and the generators and custodians of formal agricultural knowledge and information, in spite of increasing access to the Internet. It has been the subject of scholarly discussions in different parts of the world (Carl, 2007) (Baan & Samantha, 2006).

5. The Twain shall meet? ICT in rural development and ICT for Agriculture

The discussions that led to IT "reaching the unreached" (Swaminathan, 1993) also led to a series of initiatives that sought to bring the advantages of connectivity and IT in finding solutions to the challenges of rural development through a new set of approaches, later known collectively as ICT4D in international literature. Starting in late '90s, this, a global trend, had caught the imagination of many Indian thinkers, social activists, administrators as well as actors in the for-profit sector. An earlier set of reports and analysis revealed the range of activities in this area in India, and by early part of the past decade, India probably had the largest number of ICT4D projects in a single country (Keniston & Kumar, 2000). At the center of this collective of approaches was the access arrangement at the village level, known variously as “village knowledge center” or “rural information kiosks” and so on. While access to government records of various types was the dominant theme in many projects, farming or production agriculture was not a major interest in many of the initiatives (Keniston et al., 2005). The really big exception to this trend was the famous *e-Choupal* program of the ITC.

Participants in a collaborative research project carried out by the Indian Institute of Information Technology in Bangalore (IIITB) during 2005-06 covered 10 such projects (many running for over three years) in considerable depth and used the internationally accepted practices of ethnographic action research to assess the impact of such efforts (Balaji et al., 2005). The results showed that farming/production agriculture support through provision of information services via the “kiosk” was either a non-premium concern or was absent altogether. Where provision of Internet access to rural users was the principal concern, little attention was paid to fulfilling farming information needs of farmers, as reported in this study on a group of projects in South India. A subsequent analysis including more ICT4D projects from various other regions of India also revealed that farming/agricultural information support was not a priority in ICT4D projects (Guntuku, 2010). A series of analytical reports and papers from the Technologies for Emerging Markets group (of Microsoft Research-India) on sustainability and profitability of ICT4D projects also shows that farming/production agriculture did not figure among the interests that the kiosks were expected to serve for profits/income or in providing a public service to the rural population (Microsoft Research, 2010).

A series of experiments conducted by ICRISAT provided some answers for the successful implementation of farming-related information services at typical rural kiosks. In 2004, with the support of ICRISAT, the Adarsha Mahila Samikya (AMS), a community-based, all-women micro-finance organization working in Addakal region of Mahbub Nagar district in Andhra Pradesh, India, set up rural information kiosks (village knowledge centers with Internet access) in all the 21 villages where this organization is active. This region is known to suffer from recurrent, severe drought. The partners, AMS and ICRISAT have run the rural information kiosks on cost sharing basis. The principal program in this partnership was to understand how knowledge of vulnerability to drought in an upcoming season can lead to reduced economic and other losses in the region, through adoption of crop rotation and water conservation techniques. Earlier work carried out in Indian Institute of Technology-Bombay (IITB) on drought vulnerability assessment was adapted by ICRISAT to generate micro-level advisories that were exchanged using the internet-connected kiosks. The results of vulnerability analysis were presented as color-coded maps that were easy to interpret by the members of the AMS (Figure 1) AMS women volunteers were further trained in drought literacy matters and in information facilitation, to enable them to communicate farmers’ perceptions, observations and concerns to scholars and scientists at ICRISAT. They were also trained in basic techniques such as accurate measurement of rainfall and in upload of measured data into a password-protected Wiki page. This process has been ongoing continuously since 2005, and the analysis of impact shows that a number of farmers were able to cope with drought better. Many switched to drought-tolerant crops (avoiding crops such as paddy), and started to adopt conservation-oriented practices that led to saving of water for crops and animals (Dileepkumar et al., 2007).

A number of initiatives in this sector consider fulfilling farmer-queries as a key service, and deploy a variety of ICT-based methods ranging from interactive voice response systems to web-based interfaces to enable information exchange between farmer and expert. The role of women as skilled and knowledgeable intermediaries, who strengthened their knowledge and information through online interactions with experts and their learning materials, is evident in this effort. Significantly, most of the capability development effort was carried out using a blend of online and offline methods. Supplementing the work on design of web interfaces or the creation of a massive techno-infrastructure for query-response needs to be supplemented by skill building for information facilitation among willing farmers.

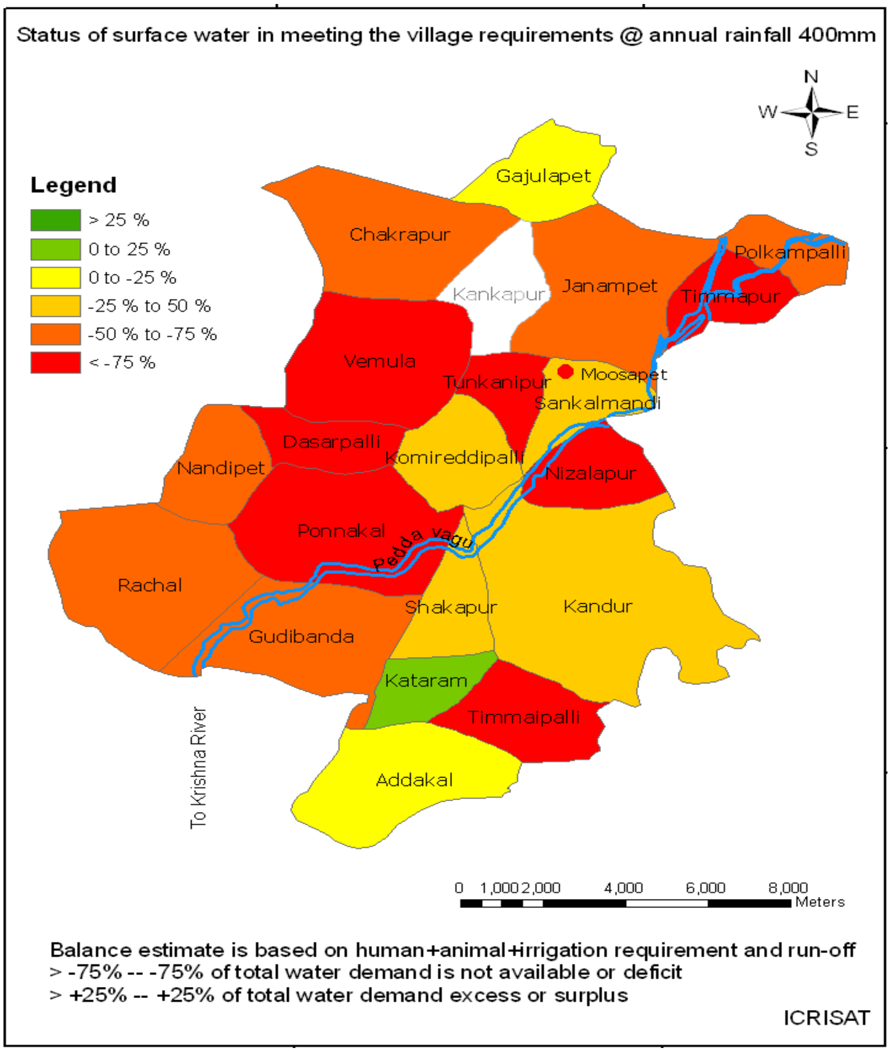

Fig 1: Sample Drought vulnerability prediction map at micro-regional level for 400 mm rainfall

These micro-level drought vulnerability maps are popularly known as drought maps among the rural communities in Addakal.

A drought map tells how much drought to expect in any village of Addakal in the coming year given a predicted annual rainfall of say 400 mm: 50% to 75% (the red areas in the map), 0% to 50% (yellow areas), and 0% to -25% (green areas) where there is up to 25% surface water available. A drought map is distributed at the beginning of the planting season so that the farmers can adjust their plans. If the predicted rainfall is more, or less, the colors change accordingly. Red is Stop and consider; Green is Go - through the all-women AMS volunteer group, the farmers in Addakal were taught to interpret the drought maps and plant their crops accordingly. The role of the women as skilled and knowledgeable intermediaries, who strengthened their knowledge and information through online interactions with experts and their learning materials is evident in this effort.

Fig 2: Women volunteers are able to play information facilitation functions, critical in information management for farming.

ICRISAT scholars in Addakal, south central India, observed that the time-to satisfactory response from experts declined from about 6 days to less than 24 hours, going down to as low as 8 hours, where trained intermediaries were available. There is a noticeable difference in information facilitation capability before and after training. The trained women volunteers (Figure 2) were able to refine farmers queries before passing them on to the experts; and were able to fine tune answers from the experts before passing them on to the farmers (Dileepkumar et al., 2005).

6. The other strand: ICT in agriculture

Institutions in the agricultural sector, especially those in education and R&D, have built and implemented projects and activities that use ICT extensively. A major initiative in this direction in India was the National Agricultural Technology Project (NATP) of the Indian Council of Agricultural Research (ICAR) that was operational for seven years during 1997-2004. This project led to the creation of an essential ICT infrastructure and Internet access in a large number of State Agricultural Universities (SAU) and in ICAR centers across the country. Although IT-related implementation slowed down after the first three years of this project, a fair amount of basic infrastructure had come into existence, even if slightly inadequate for the size of the challenges it was expected to handle. However, capabilities necessary to build and maintain information and data services relevant to farmers had not been created adequately, with the result that the presence of institutionalized agriculture in India on the Internet was and has remained minimal.

The State Agricultural Universities in India play a pivotal role in sustaining and advancing agricultural productivity, and are responsible for the development of what are known as the "packages of practices" documents for each crop that is cultivated in a State. This document is an official one and has many levels of review and approval prior to release. The SAU's also manage a very large proportion of the KVK's (see above) to enable farmers to get information and training in important new production technologies, and are expected to provide farm advisory and alert services. While many SAU's have created a minimal IT and connectivity infrastructure over the last about twelve years, the momentum to sustain and advance the infrastructure was not generated. Making the accumulated data on technology trials available online or building digitally enabled information and advisory services for farmers is not yet a priority or routine activity at the SAU level. The net result is that few of the packages of practices documents are available online. Few, if any, research projects in this system consider online publication of results as a serious output.

The national program for farmers' call centers, called Kissan Call Centers, operates in almost all States of India since 2004 but not all the SAU's are active participants in it, and the initiative itself is not seen as being particularly effective, and no impact assessment has been published yet. A few States such as Andhra Pradesh have their own farmers' call center whose operations are supported by the SAU..

A recently completed study at ICRISAT showed that most SAU's are not in a position to offer agro-meteorological alerts online within their own territories. A notable and large exception is the Tamil Nadu Agricultural University (TNAU) which, since 2008, has placed on the web nearly all its extension material (AGRITECH, n.d.). The TNAU has also placed on the web near real-time data from its weather stations from across the State of Tamil Nadu (about 224 stations), making it a true pioneer among agricultural universities in developing countries (Anon., n.d.).

The national research laboratories, centers and field stations under the ICAR are better networked compared to the SAU's and have a better presence on the Web. Yet, few of them have Web 2.0 features or have other arrangements to enable interactivity with the "clients" (ICAR, n.d.). The ICAR directorate of information and publications (DIPA) does not yet have significant presence on the web; as a result, critical documents, especially ones with historical value in terms of data, information and images are unavailable to build and sustain services. In the last two years, there are ongoing efforts at the Indian Agricultural Research Institute to build an Open Access repository of research publications and a small number of professional research societies are also moving in this direction (IARI, n.d.) (CIARD, n.d.). Key data sets and information on soil and water management, gathered, analysed and stored in a number of ICAR centers, are not available online yet. This gap and the non-availability of meteorological information has led to failure to forecast key diseases, an example being the potato blight that affected production significantly in large parts of north western part of the Gangetic Plains in 2009 (Anon., n.d.).

India's National Informatics Center (Anon., n.d.) has for long been an active player in making agricultural information available online, and initiated the *Warana Wired* Village (Anon., n.d.) project in 1998 in Maharashtra which was unique in the way it brought together agricultural information with "kiosk" operations focusing on a single crop, namely, sugarcane. While that initiative could not be sustained, NIC has placed online market prices of key agricultural produce for most of the district headquarters (AGMARKNET, n.d.); similarly, NIC has also been able to bring together nearly all the digitally published POP's of SAU's (ICAR, n.d.), although the proportion of digitized POP's is still small. Lack of role clarity between NIC and the Union Ministry of Agriculture (Department of Agriculture and Cooperation-DAC) in such publication process has been noticed for a long time and addressing this would help make available a larger quantum of agricultural information online. The DAC's web site is primarily a collection of static pages (Anon., n.d.).

These are among the large or long-running activities that use the Internet as a medium to enable access to agricultural information and data for farmers and their organizations. The *Digital Green* (Anon., n.d.) is an non-profit initiative is a key emerging player. This initiative is premised on the idea that promoting farmer-farmer exchange of information and building the facilitational capability of farmers using video is an effective way to improve production value and conservation of resources. The Indian Space Research Organization (ISRO), through its closed user group network of Village Resources Centers (http://www.isro.org/publications/pdf/VRCBrochure.pdf), has enabled direct interaction between experts in institutions and farmers in many parts of the country during 2005-2010 although few SAU's were found to be partnering in this activity as of 2010. As we had noted earlier, the well- known e-*Choupal* program uses more of non-Internet networking to build an arrangement for sourcing of select farm produce while assuring better realization of value to farmers and consumers. This is a well-documented effort (Kumar, 2004) (Dileepkumar et al., 2006) and is not covered in detail here.

When it comes to commodity pricing, significantly larger number of efforts are found and they operate on a reasonably large scale using a blend of Internet access and closed user group. The NIC AgMarkNet (AGMARKNET, n.d.) is the longest running activity of this kind. The National Horticultural Board (Anon., n.d.) has set up a price information system on the web with limited analytical features. Best known is the effort of India's MCX (multi-commodity exchange) which covers several traded agricultural commodities extensively, with fine-grained pricing available for a smaller number of crops covering some regions of Maharashtra (Anon., n.d.). Similar efforts of India's NCDEX (National Commodity and Derivative Exchange) are also notable (Anon., n.d.). A new effort involving a consortium of universities led by the TNAU focuses on prices forecast for select commodities in an accurate fashion, building on a widely-tested simulation developed at TNAU. This much needed effort is still an experimental project. In general, market price information, although not available easily at scales below that of a district in India, is better visible on the Internet, while the same cannot be said of "material" (soil, water, seeds and other inputs) or meteorology. The original expectation, articulated in the early '90's that the Internet will help fill gaps in the availability of information on 3M's is still unfulfilled in India.

A different group of projects that combined elements of ICT4A with ICT4D has been developed by mainly IT expert resources. Three among them are the aAQUA (AAQUA, n.d.) by IIT-Bombay, DEAL (DEAL, n.d.) at IIT-Kanpur and the KISSAN-Kerala (KISSAN, n.d.) of IIITM-Kerala. Another notable one is the *e-Sagu* project of IIIT-Hyderabad (E-SAGU, n.d.). Of these, KISSAN was the most deeply integrated with institutionalized agricultural expertise, and had its own regular episodes on a popular TV network. The Agropedia has evolved from DEAL (see above) in partnership with a Consortium of institutions comprising ICT resources (IIT-Kanpur, IIITM-Kerala, IIT-Bombay) along with leading institutions with agricultural domain expertise (www.akmindia.in). Agropedia has been envisoned and architected by a group at IIT-Kanpur as a semantically enabled platform for agricultural information management and is, in the present phase, enabled with features for information exchange via mobile telephones. These two initiatives provide a view of what synergies between leading ICT resource institutions and research and extension institutions in farming can achieve in drastically improving knowledge exchange between instititionalised expertise and farmers.

7. KISSAN-Kerala: exemplifying delivery of farm information services in multiple modes

Karshaka **I**nformation **S**ystems **S**ervices **A**nd **N**etworking (KISSAN) is an integrated, multi-modal delivery of agricultural information system, which provides several dynamic information and advisory services for the farming community across the State of Kerala. It is one of the citizen centric e-governance projects of the State Government. The project was conceptualized, designed, developed, implemented and managed by the Indian Institute of Information Technology and Management- Kerala (IIITM-K) (www.iiitmk.ac.in).

The basic objective of this project is to provide contextualized information to the farming communities dynamically using a combination of Web interfaces, Television- based mass media programs, Telephone- based advisory, Mobile (text/voice/video) based advisory and broadcast service, and dedicated branded Internet video channel on agriculture. It involves collaboration of experts from key organizations for effective information delivery on demand seamlessly to all farmers in a seamless manner.

The key feature of KISSAN is the integrated service delivery model. The major services are

- ***Online Agri advisory service:*** The dynamic portal based onlineadvisory service (www.kissankerala.net) is a major output of the project. The portal provides an online platform for the farmers to interact with the expertsresearch scientists and agricultural extension officers in an interactive way. The portal also provides several dynamic advisory services like market information, weather and crop advisory, and an expert system on fertilizer recommendation besides others. Through an online query management system, the experts in the project have answered more than 18000 queries of the farmers in the last five years. Through the online fertilizer recommendation system, the farmers have generated or received more than 35000 online fertilizer recommendations (in the local language, Malayalam) for their preferred crops.

  Development of a web-GIS based dynamic weather information and forecasting system (for the entire state of Kerala is a major feature of this portal. The system currently gives more than 300 weather locations across all districts of Kerala**.** It gives three basic weather parameters, namely, temperature, cloud cover, and precipitation (rainfall) for each location with weekly prediction.

- ***Kissan Krishideepam:*** *A weekly Agriculture Television program - in Malayalam language* that provides select information on best practices, success stories, departmental news, news on various farming related public programs, market analysis, cultivation methods, and analysis of current issues, etc. Care has been taken to ensure that *KISSAN Krishideepam* is authentic. It is produced in-house at IIITMK by agricultural and media experts. The project produces and telecasts a weekly television program (30 minutes duration) over a leading satellite channel (Asianet) in Kerala. The program now reaches to more than five million regular viewers across the State and beyond. The project has completed the production and telecast of 370 unbroken weekly episodes during the last 8 years.

- ***Online Agri video Channel:*** launched India's first branded online video channel in agriculture in collaboration with YouTube. More than 150 selected videos (telecast quality) are available through this channel.. (www.youtube.com/kissankerala).

- *Tele Advisory Services**:*** The project also provides telephone based Agri advisory services through a dedicated telephone number for farmers. The farmers can ask any questions to the agricultural scientists and seek expert advice for their crops. As part of this service, the project has developed an extensive crop database across the state to provide location specific advisory services.

- *KISSAN Mobile based advisory* **–**Kerala is considered to be one of the States in the country where mobile penetration is very high KISSAN has launched several mobile based services via SMS (PUSH and PULL), voice and video based services to the farming community (www.kissankerala.net/mobile)

Some of the mobile based services are: *information on the availability of planting materials* is a service that helps farmers locate and purchase quality planting materials from the nearest farm/nursery; *weather information and advisory for farmers* helps famers obtain weather information for the locality and covers six parameters that are important in farming; *two-way query answering system (Ask our Experts through mobile);information on the soil health* (Through this service, the farmers can easily procure the test results in the least possible time, which normally runs to weeks if not months). *voice- based monthly crop* *management advisory* (farmers will get an automated voice call as output depicting the different operations for the concerned crop in the given month).

The key feature of KISSAN is the services delivery model that makes available to the experts from any agriculture related organization any mix or all of the above modes of communications to reach farmers anywhere in the state. This is a new Internet -driven services delivery and knowledge system that enables coming together of multiple stakeholders to enhance the services provided to farmers more effectively than they were earlier able to. This has been made possible by the coming together of institutions as well as the deployment of an integrated services delivery model

8. Agropedia: multiple strands coming together

During the last three years, a consortium of IT resource institutions and agricultural universities and research institutes came together with the support of the National Agricultural Innovation Project- NAIP (AKM-India, n.d.) and developed a series of prototypes with delivery modeled after KISSAN-Kerala. The content organization was built completely anew. Called *Agropedia* (Agropedia, n.d.), this platform involves the use of semantic web practices, especially of knowledge models, with FAO's Agrovoc (AGROVOC, n.d.) serving as the basis of an ontology for crop information. *Agropedia* was conceived of and architected by a team at IIT-Kanpur (Anon., n.d.) and the validation of crop knowledge models for nine crops was carried out by a number of agricultural subject matter experts from all over India, especially those at the partner institutes, namely, ICRISAT, University of Agricultural Sciences-Raichur, and the GB Pant University of Agriculture and Technology.
Architecture of Agropedia is based on the idea that semantic enablement of information management via a web interface would significantly contribute to addressing the language diversity in Indian farming. It is also enabled with what are now accepted as typical Web 2.0 interfaces, namely, Wikis and blogs. To allow for participation of experts and practitioners outside the milieu of institutions, Agropedia allows for two tracks to contribute information: one, termed Gyandhara (Hindi equivalent for formal knowledge) is available for use by institution-affiliated experts; the track called "jandhara" (Hindi equivalent for popular knowledge) is open to anyone. All contributions are available for browsing and commentary by anyone. This satisfies the institutional view that all farming information has a prescriptive element and needs to rise through a validation process (Gyandhara).

The semantic aspect is in the way contributions and commentaries are tagged, using a knowledge model for the topic. In the current phase, a crop is identified as a topic and a knowledge model is built for each crop. The model for pieonpea crop is given in Figure 3. This is arrived at through a series of workshops where experts from the agricultural research and education institutions come together and validate the model through reaching a consensus on the placement of concepts and their relationships. This approach has enabled searches for information in four different languages (English, Hindi, Kannada and Telugu). As of now, nine crop knowledge models have been developed and content in all the four languages mentioned is available on these crops.

In the ongoing phase, Agropedia designers have also created tags for research information and have further built an automatic tagger for research publications in agriculture (Agrotagger- http://agropedialabs.iitk.ac.in). They have also added features that allow delivery of crop advisory by a field-based extension worker to a select group of farmers. Depending upon the level of access to networks, such advisory can be received on email, voice or text. Integration of such features in Agropedia makes its architecture that is scalable for both content aggregation and integrated, multi-modal delivery.

The IIITM-Kerala, host of the KISSAN-Kerala project, has designed and built Open Web GIS interfaces that enabled a user to overlay weather information and soil micro-nutrient deficiency to enable better recommendations on fertilizer input management to farmers at a local level (http://www.akmindia.in/agrogis/dhwd1/index.php).

With these two significant crop-or animal or topic-specific services for a wide variety of farming conditions can be created.

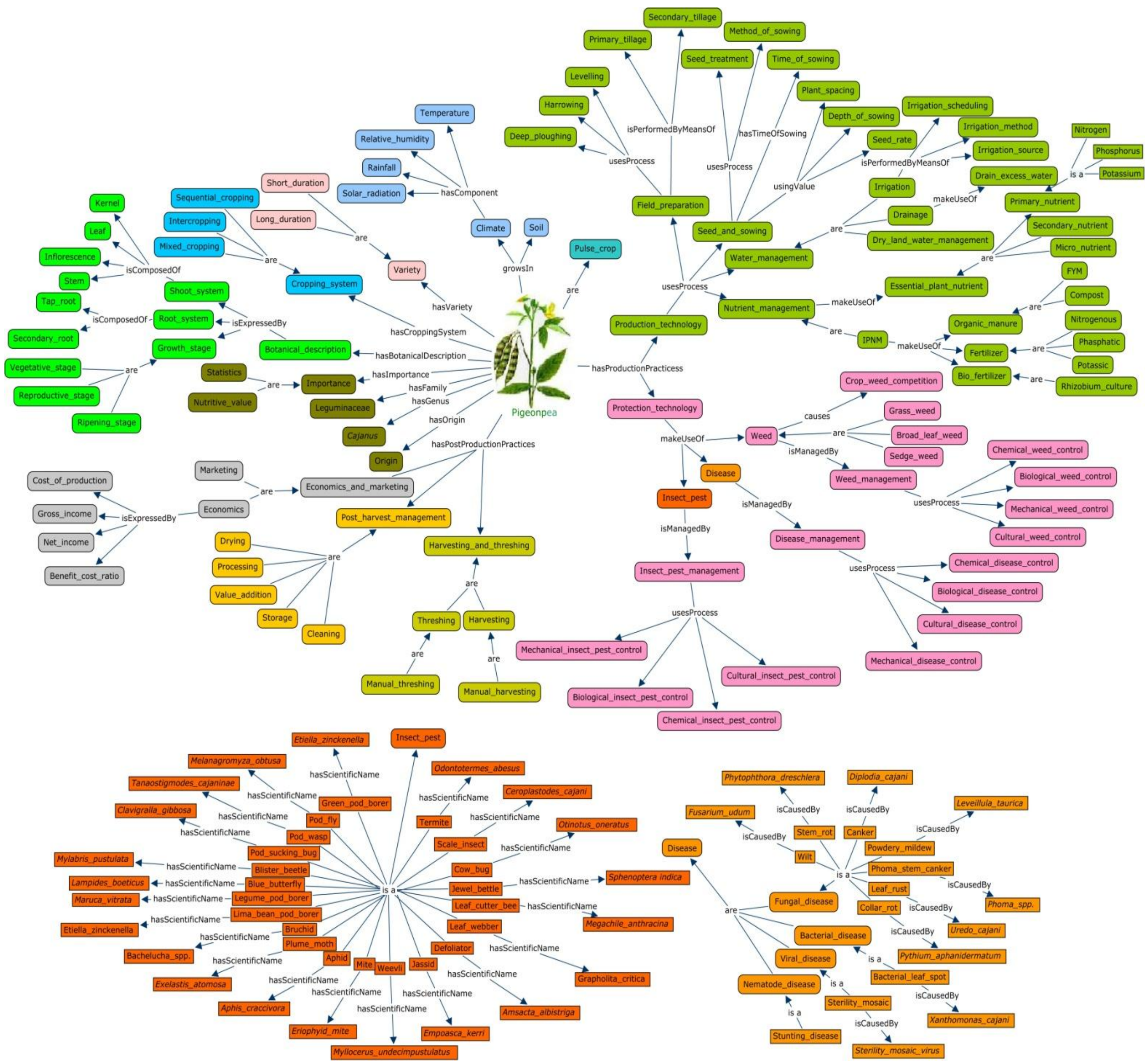

Fig 3: Pigeon pea Knowledge Model Map
(http://agropedia.iitk.ac.in/?q=content/knowledge-models)

9. ICT Contributing to Agrarian Prosperity in India: the twain must meet

We have pointed out that there is a significant gap in availability of farming/agricultural information and data on the Internet and it is a global phenomenon. It is more acute in India. The non-priority status for farming information in the rural "kiosks" and e-Governance projects in India has given rise to a divergence between investments and interests that drive applications of ICT in agriculture and in rural development. This is needs to change.

A significant part of the responsibility in changing this is actually with the institutionalized expertise in agriculture, whether in public or private, in the for- or non-profit sector. The absence of a digital content infrastructure for India as a whole is the biggest impediment in launching meaningful, large scale information and advisory support for the farmers of India. Similar to the investments made by various public agencies in improving network connectivity, the key stakeholders in India's vast agricultural sector must consider this a priority area for policy attention and investment. Considerable synergies need to be built as well. Given the history of good intentions and foresight that are coupled with lack of capabilities and motivation, this large task will require the participation of a number of non-standard actors. The recent success in bringing together leading ICT resources and agricultural domain expertise shows that the role of non-traditional, emerging stakeholders is important. The older and continuing attitude of favoring verticality of processes where agricultural sector would build an end-to-end solution in IT matters should be given up.

The IT researchers in the public sector and in industry need to carefully assess if all the technological solutions needed are readily available to meet the complex and multi-dimensional challenges of information and data management in Indian farming. There is no pre-built, readily accessible data and content organization with which services can be created for various stakeholders in Indian agriculture whose diversity is immense. Lack of appreciation of this, in our view, has led to many fragmented efforts in recent times. The digital content infrastructure for farming in India does not exist and needs to be built as a mandate. The rapid and extensive spread of mobile telephony is leading to the launch of new initiatives for rural areas. All such initiatives in deployment of mobile telephony as the delivery mode of choice (for example, the AIRTEL-IFFCO IKSL project - http://www.iffco.nic.in/iksl/ikslweb.nsf) will also require the availability of an advanced content organization on the Internet for sustenance. Internationally, access of farmers to institutional expertise and information in agriculture has not been a serious challenge in countries with industrialised agriculture and as such they can offer no models for India which needs to build its own, possibly pluralistic model. Significant investments and synergies are essential and they need to come from a variety of stakeholders including non-traditional ones.

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