Model Training Course
w.e.f. (15-22 December 2010)

A TRAINING MANUAL

Information and Communication Technology and Improved Agricultural Practices for Enhancing Productivity under Changing Climate Situation

Sponsored by
Directorate of Extension,
Department of Agriculture & Cooperation,
Ministry of Agriculture,
Government of India

Course Director
Dr. K. M. Singh
Co-Course Director
Dr. M. S. Meena

Organized by

ICAR Research Complex for Eastern Region, ICAR Parisar (P.O.: BVC) Patna-800 014 (Bihar) India

About Authors

Dr. K. M. Singh
Head, Division of Socio-Economics & Extension

Dr. M. S. Meena
Senior Scientist, Agricultural Extension

Citation: Singh, K. M and Meena, M. S. (2010). Information and Communication Technology and Improved Agricultural Practices for Enhancing Productivity under Changing Climate Situation, Training Manual, ICAR Research Complex for Eastern Region, Patna, Bihar.

CONTENTS

ICT in Improving Efficiency of Fresh Water Aquaculture Sector

Dr. D. K. Kaushal, Head

Aquaculture is a livestock-rearing business that has developed and grown considerably during the last decade. As a major supplier to the food trade, the Indian aquaculture sector has had to learn how to produce & integrate its products within markets that are increasingly more complicated to supply and to understand. A little background on the sector's history is without doubt, necessary and this communication will concentrate on the commercial fish farming sector of aquaculture besides ways of multiples use of water. The main reason why people have invested in aquaculture is to be able to make a profit from this farming activity and, historically, the freshwater major carps and trout sectors were the first professional elements of commercial fish farming. These developed slowly at the beginning using artisanal production technology where young fish stocks were reared in ponds or tanks. The development of transportation technology allowing movement of young fish from hatcheries to on-growing farms, combined with the industrial manufacture of polluted feeds made to the dietary requirements of different species & adoption of polyculture, led to a very rapid expansion of the sector's production in the 1990s. During this period, trout and carp farming developed very rapidly in different areas of India. In addition, growing market-size freshwater prawns and cat fishes also became a viable commercial activity. More recently, additional species have been added to the list of potential products notably L.bata, L.dyochelius, P.sarana, and P.sutchi et. The application of information and communication technology has varying topics of interest in improving the aquaculture production. In addition, the fish farmer does not have the possibility of landing his catch at a market with the infrastructure for sales & distribution. It is these sectoral characteristics that make the modern Information Communication Technology ideally suitable and even essential for the sector's future.

Opportunities to enhance aquaculture contribution to National Development

Aquaculture as a potential contributor to the national development is presented with lots of opportunities and some which are:

- Aquaculture can be easily integrated into conventional farming including small scale crop and animal production in rural areas and maximize resource use.
- Aquaculture management involves issues of conventional farmers e.g. stocking, feeding and harvesting etc.
- Aquaculture leads to equitable access to aquatic resource use.
- The government is harmonizing policies and regulation essential to aquaculture development.
- The government has put in lots of effort for research and development and technology transfer which are pre-requisite for the industry.
- An appropriate trained force is essential to aquaculture development.

Major challenges for Aquaculture Development

- Uncoordinated promotion of aquaculture through many institutions.
- Lack of certified quality seed and commercial feed.
- Demand driven research programmes.
- Inadequate training programs for farmers and extension workers.
- Inadequate record keeping by the farmers.
- Low investment by the private sector.
- Lack of credit.

Multiple water Uses Opportunities for Enhancing Water Productivity

In order to derive maximum benefit from the depleted or diverted water and maximize output to increase water productivity, the productive or beneficial interventions of multiple nature both non-consumptive and less water consumptive such as fisheries, aquatic crops, aquatic resources, livestock etc. may be integrated into the existing irrigation and water use systems/water infrastructures. Such multiple use of water is aimed at:

- Enhancing water productivity
- Increasing farm productivity without any additional diversion of water
- Enabling diversification to high value outputs
- Reducing risk, better use of resources and increased resource use efficiency
- Ensuring increased income and better flow of income throughout the year
- Enabling better utilization of otherwise wasted/depleted water resources, water congested/waterlogged areas.

It is increasingly recognized that promoting multiple water use entails significant, but largely untapped opportunities to enhance water productivity. However, conventional irrigation systems, water harvesting schemes and water supply systems tend to ignore or lack multiple uses of water and have rarely considered this aspect in planning and design. Multiple water use systems distribute water from several sources such as canals, streams, rivulets and springs in hills, pumped ground water, water harvested from watersheds or roofs, and may also include unused or underutilized water bodies (small or big) and water congested areas and use of poor quality waters in peri-urban areas. Even though their qualities may be different, there is sufficient similarity to treat them in the first instance, as contributing to the same 'pool'. In India and elsewhere in developing or under developed countries, a lot of interest has been generated and work on multiple water use has been undertaken at experimental farms, watersheds and farmers field. Evidences of multiple uses could be found in irrigated, rainfed, water logged, coastal and hilly areas/ watersheds.

ICT Needs of the Aquaculture Sector

Production Aspects

Commercial aquaculture requires good technical and financial management, where production monitoring and efficiency is a key element. For example, feeds represent one of the major cost items in the business and accurate data on stocks and other parameters are needed in order to manage efficiently and minimize the waste. All farmers are looking for optimal growth at the lowest cost and a number of increasingly-sophisticated computer programmes are currently available for this purpose, allowing much improved operational planning to be achieved. Analyzing production data to provide accurate harvest forecasting is without doubt one of the keys to operating a successful modern farm. Seasonal demand and price fluctuations are common for many fisheries and aquaculture products but where aquaculture should have the significant advantage of being able to plan production and harvest rather than rely on the variant conditions encountered by capture fisheries.

Marketing Aspects

Increasingly sophisticated sales and marketing strategies are required. The absolute need to abide to the consumer safety laws and requirements for food processing has mirrored increased processing activity by many aquaculture companies. Although one often refers to 'added-value' products from processing, the absolute need to respond to the consumer's wishes and desires infers, that packaging and processing have become a means to sell rather than an option. Consequently, part of the production sector has moved towards processing in order to get 'closer' to the consumer by manufacturing a product that can be sold to a retailer, the chain of intermediaries has been reduced. Companies investing in this part of the business no longer need to pass through the lines of

1. Wholesale
2. to Processing (optional)
3. to Market

thus reducing the Distribution logistics and costs associated with these sectors. This concept has not been possible for those in the sector who do not possess the capacity, in terms of production or finance, to make the jump towards processing, noting that ready-to-eat meals are one of the fastest growing sector in the food business in India. The further complications of small company size in addition to geographic and product dispersion have already been mentioned. Individual or co-operative investments in this sector are now responsible for a large part of the sales of aquaculture's products, adapting to and evolving with the modern market's requirements. Evidently, traditional IT products for business management are considered essential within such an environment.

Information Requirements

In summary, the aquaculture characteristics include:

1. wide geographic dispersion
2. production specialization (mono or very few species)
3. production limitations (site licenses limiting production)
4. distance from major markets

The traditional producer response to counter falling prices is increased production. In many cases, farms have exceeded the capacity of their local market and the economies of scale required for increasing efficiency have put particular pressure on both inter and intra-company communications. This phenomenon is changing and modernizing the way in which the aquaculture industry operates. There is a recognized need for accurate, trustworthy and readily available market information since this is required for both short and medium term planning of production, harvesting, processing and sales. Consequently, the real and potential facilities accorded by information technology and electronic communication are being integrated into the sector, albeit slowly. Around 2% of aquaculture businesses use the Internet and that most of these are relatively large companies. The evident cost benefits of using the Internet for information communication has moved on from being technically led, in the same way that aquaculture was, to being market-led and answering to consumer demand. Simpler user technology and immediate results are the most convincing argument to attract those involved in the production sector. Busy technical and sales staffs do not have the time to 'surf' the Internet; they want to find the information that they want or need, quickly & efficiently.

If the service is good, they will use it. There is considerable hope for the application of electronic information and trading mechanisms that would help the smaller rural and/or coastal producer to be able to benefit from the concept of the shorter distribution chain described. The challenge of using direct communication lines between the seller and the buyer, who is at the closest point to the consumer, probably represents the only way in which a producer will be able to make an adequate profit margin while selling at a real market value. This would be because the costs charged by intermediaries would not be passed down and added to his ‘ex-farm’ price. The reality of this situation, referring particularly to declining prices and increasing costs, is evident to those working within the sector. The Internet now provides low-cost and efficient communication where developments in data encryption and electronic payment facilities, are providing an increasingly safe desktop environment for conducting business. When these factors are combined with adequate information services for technical and marketing data, the scene is being set for the most significant leap forward in efficiency that the sector could hope for.

Conclusion

There are many identifiable subjects that are appropriate for ICT and from which the aquaculture sector could benefit but if these projects are to succeed, the following criteria should be respected:

- Clear and focused services
- Simple and user-friendly
- Accurate information
- Well organized and easy to find

Closer co-operation between developers and industry operators has to be stimulated in order to encourage real progress. It is important to avoid dispersion and distancing from the wishes and desires of the end-user in this development phase.

ICTs and Climate Change with reference to Crop Production

Dr. S.S. Singh
Head, Division of Crop Research

ICT or Information and Communications Technology in simple terms, can be defined as the basket of technologies, which assist or support in storage, processing of Data/Information, or in dissemination/ communication of Data/Information, or both. ICT thus includes technologies such as desktop and laptop computers, software, peripherals and connection to the Internet that are intended to fulfill information processing and communication functions. According to Wikipedia (2008), the term ICT is the broader term of Information Technology (IT), to explicitly include the field of electronic communication, in addition to IT. The term IT is defined as "the study, design, development, implementation, support or management of computer-based information systems, particularly software applications and computer hardware." IT deals with the use of electronic computers and computer software to convert, store, protect, process, transmit and retrieve information, securely. The relevance of ICTs for Agricultural Development in general and for Agricultural Extension in particular is extremely high for a country like India. ICTs are most natural allies to facilitate the outreach of Agricultural Extension system in the country. Despite a large, well-educated, well-trained and well-organized Agricultural extension manpower, around 60% of farmers in the country still remain un-reached, not served by any extension agency or functionary. Of the 40%, who have some access to Agricultural Information, the major sources of this information are Radio and Television. The telephone has just started to make its presence felt on this scenario. Internet-supporting Information-Kiosks are also serving the farming community, in many parts of the country. Hence ICTs are highly relevant for Agricultural Extension scientists, researchers, functionaries and organizations. Climate change is one of the most complex challenges that humankind has to face in the next decades. As the change process seems to be irreversible, it became urgent to develop sound adaptation processes to the current and future shifts in the climate system. In particular, it is likely that the biggest impacts of changes will be on agricultural and food systems over the next few decades. Several researchers, thanks to the application of crop modeling tools, have pointed out that climate change is likely to reduce food availability because of a reduction in agricultural production.

The Intergovernmental Panel for Climate Change (IPCC), a committee of the United Nations that every five years collects and reviews the most important scientific contributions to this issue, put in evidence that higher frequency and diffusion of climate fluctuations is likely to produce more severe and frequent droughts and floods, which already are the main causes of short-term fluctuations in food production in semiarid and sub-humid areas. Intergovernmental Panel on Climate Change (IPCC, 2007) in its fourth assessment report (AR4) indicated with very high confidence (90% probability of being correct) that human activities, since industrialization have caused the planet to warm by about 1^{o}C and future climate change is likely to affect agriculture, increase risk of hunger and water scarcity. Future projections of climate change using Global and Regional Circulation Climate Models with different IPCC emission scenarios indicate an increase of about 5-10% in summer monsoon rainfall over India (NATCOM, 2004). It is also projected that number of rainy days may decrease by 20 to 30%, which would mean that the intensity of rainfall is expected to increase. Extremes in rainfall also show increase in their frequency and intensity by the end of the year 2100. Within this framework, it is crucial to identify information and communication systems that the farmers need in order to cope with the new conditions. This is particularly true for poor smallholder farmers, farmers do not have access to the scientific and technological advances that support agricultural decision-making because of the lack of reliable communication networks. With regard to agronomic research, one of the major challenges will be to study how to fill the information needs of policy makers, and how to report and communicate research results in an effective way for supporting the adaptation of food systems to climate change.

Information systems on climate change at local to regional level

At the present time it is possible to recognize three major categories of information systems developed to study the issue at local to regional level. They are comprehensive systems and methodologies for institutions; downscaling tools for working at national and sub-national level; and systems and tools for specific sectors (e.g. agriculture, forestry, etc.). The first category comprises essentially theoretical methodologies based on different assumptions and approaches, developed to identify and quantify climate change impacts (e.g. IPCC Guidelines, UNEP handbook), assess vulnerability to climate change (e.g. UNEP Adaptation Policy Framework, APF) or do both kind of analysis (e.g. Assessments of Impacts and Adaptations to Climate Change, AIACC; UNFCCC Guidelines for National Adaptation Programmes of Action, NAPA) at an institutional level with a systemic approach.

The second category includes all the tools needed to produce climatic data at an appropriate scale for impact modeling and scenarios development at local to regional level (e.g. the 'Statistical Downscaling Model', SDSM; the 'Country Specific Model for Intertemporal Climate', COSMIC; the 'Providing Regional Climates for Impacts Studies' tool, PRECIS). Downscaling tools are applied in order to develop climate information at high resolution through the processing of global climate models built with General Circulation Models (GCM): these global models cover areas of 150-300 kilometers, so cannot be used to study climate impacts at local levels. Two different downscaling techniques do exist: the dynamic and statistical one. The former is the most complex and expensive method, and it's the result of the application of high-resolution and regional climate models: it's particularly useful in data-poor regions, but it requires high computing power and expertise. Statistical downscaling (often used jointly with atmospheric/weather generators) is a two-step process, which starts from the definition of statistical relationships between GCM-scale variables (assumed constants) and observed small-scale variables; the second step is the application of this relationship to the results of GCM experiments. Compared to the former technique this method is cheaper and simpler to use, but it needs large quantity of data and therefore it can be applied in data-rich areas only. The third and final category is composed by all the information tools through which it's possible to investigate climate change issues within specific sectors: economy, human health, coastal protection, agriculture, water management, forestry, and so on. The range of systems and tools which belongs to this category is extremely wide, covering (or at least trying to cover) all the information-based issues of such a cross-cutting phenomenon. The next paragraphs briefly describe the ICT dimension within climate change linking it to the single agricultural sector, as well as looking at development steps of an adaptation strategy.

ICT for climate change within the agricultural sector

In the intersection between climate change and agriculture there are several tools available, because of the high number of crops and because of the complexity of replicating the same conditions across different regions. Every tool allows analyzing different processes of the agricultural sector, from local crop modeling under climate change conditions to the management of economic impacts of climate change on the agriculture sector (soil value variations, demand and supply, production, etc.), and so on. As many tools exist, it's interesting to focus on their common aspects rather than their specific peculiarities. Some of the tools allow simulating the growth of specific crops, verifying their variations under different climate change scenarios. Usually these tools are site-specific, but they can be applied at national and/or regional level through a link to an appropriate Geographic Information System (GIS). The first step of the applications happen with the definition of boundary conditions (which include data on crop calendar, soil status, etc.) and input climate parameters and data (such as: temperature, precipitations, wind speed, global radiation, soil moisture, air humidity, water flows...); some of the tools include also data related to crop management conditions. The second step is the development of the growth simulation in a specific state of potential crop production (e.g. with a certain fixed amount of water resources and nitrogen production) for different management options and for a chosen climate change scenario, through the link to an appropriate GCM or an ad hoc expert system. The general output of this kind of software is the assessment of crop production under given scenarios, facilitating decision making at farm level up to a whole crop system.

Examples of these tools are:

WOFOST-developed by the Centre for World Food Studies, CFWS, in cooperation with the Dutch University of Wageningen: it can be applied on several different crops, such as barley, field bean, maize, potato, rice, soybean, sunflower, wheat, etc.

GOSSYM/COMAX, developed by the Universities of Clemson and Mississipi and the Agriculture Department of United States: it is the merge of the GOSSYM model, used to simulate cotton growth, with COMAX (CrOp Management eXpert, an expert system), GCMs and weather generators to study the effects of climate change on cotton production.

APSIM (Agricultural Production Systems SIMulator), developed by a consortium of universities and departments of the Australian state of Queensland named Agricultural Production Systems Research Unit (APSRU): it can be applied on more than twenty crops and plants, such as alfalfa, barley, chickpea, cotton, eucalyptus, lupin, maize, peanuts, sugarcane, sunflower, tomato, wheat, etc.

DSSAT (Decision Support System for Agrotechnology Transfer) developed by the International Consortium for Agricultural Systems Applications (ICASA) incorporates crop/soil/weather models, data input and management software, and analysis programs for optimizing production or profit for homogenous fields. This simulation model covers 18 crops. It also includes links to GIS and remote sensing information, which allows mapping of spatially variable inputs across a field and mapping of predicted outputs from the models, such as yield, nitrogen leaching, water use, etc. The site specific yield potentials can be estimated determining spatial pattern crop and land information and using it in above simulation models.

INFOCROP developed by IARI, New Delhi also incorporates crop/soil/weather sub routines for analyzing productivity variations under different climate change and related management scenarios. These models can be used for potential production estimation, optimization of management practices and irrigation scheduling under climate change conditions.

Global Positioning System

The Global Positioning System (GPS) is a satellite-based navigation system that can be used to locate positions anywhere on the earth. GPS provides continuous (24 hours/day), real-time, 3-dimensional positioning, navigation and timing worldwide in any weather condition. GPS was originally intended for military applications, but in the 1980s, the government made the system available for civilian use. There are no subscription fees or setup charges to use GPS. Any person with a GPS receiver can access the system, and it can be used for any application that requires location coordinates. The development of the publicly available global positioning system (GPS) has opened new doors in opportunities for spatial data (Sahoo, 2010). More recently farmers have gained access to site specific technology though GPS. GPS makes use of a series of satellites that identify the location of farm equipment within a meter of an actual site in the field. The GPS positional accuracy when used in single receiver mode (autonomous navigation) can be degraded by various error sources. The positional (horizontal) accuracy of the GPS can be of the order of 20 m. In order to achieve the required accuracies, especially needed for precision agriculture, the GPS has to be operated in a differentially corrected positioning mode, i.e. DGPS. In the DGPS, the errors computed by a reference station, which is located in a known place, is transmitted to the mobile user and error correction is done to improve the accuracy. The most common use of GPS in agriculture is for yield mapping and variable rate fertilizer/pesticide applicator. GPS are important to find out the exact location in the field to assess the spatial variability and site-specific application of the inputs. The positional (horizontal) accuracy of the GPS can be of the order of 20 m. GPS operating in differential mode are capable of providing location accuracy of 1 m and also submeter. The availability of GPS approaches to farming will allow all field-based variables to be tied together. This tool has proven to be the unifying connection among field variables such as weeds, crop yield, soil moisture, and remote sensing data.

Remote Sensing Technique

Remote sensing (RS) is the science of making inferences about material objects from measurements, made at distance, without coming into physical contact with the objects under study. A remote sensing system consists of a sensor to collect the radiation and a platform–an aircraft, balloon, rocket, satellite or even a ground-based sensor-supporting stand-on which a sensor can be mounted. Currently a number of aircraft and spacecraft imaging systems are operating using remote sensing sensors. Some of the current image systems from spacecraft platform include Indian Remote Sensing Satellites (IRS), French National Earth Observation Satellite (SPOT), IKONOS, MODIS etc. However, using RS data for mapping has many inherent limitations, which includes, requirements for instrument calibration, atmospheric correction, normalization of off-nadir effects on optical data, cloud screening for data especially during monsoon period.

Geographic Information System (GIS)

GIS is a computerized data storage and retrieval system, which can be used to manage and analyze spatial data relating crop productivity and agronomic factors. It can integrate all types of information and interface with other decision support tools. GIS can display analyzed information in maps that allow (a) better understanding of interactions among yield, fertility, pests, weeds and other factors, and (b) decision-making based on such spatial relationships. Many types of GIS software with varying functionality are now available. Many farm information systems (FIS) are available, which use simple programmes to create a farm level database. A comprehensive farm GIS contains base maps such as topography, soil type, N, P, K and other nutrient levels, soil moisture, pH, etc. Data on crop rotations, tillage, nutrient and pesticide applications, yields, etc. can also be stored. GIS is useful to create fertility, weed and pest intensity maps, which can then be used for making maps that show recommended application rates of nutrients or pesticides. These GIS tools can be used for creating spatial maps of different crop, weather, soil parameters from point data set.

ICT for climate change adaptation: the application process
In relation to the application of ICT for climate change adaptation, different strategies are being developed according to local conditions and following the main steps of every adaptation process:

Observation. This phase is crucial to understand how climate variations are occurring in a specific (regional/national/local) area. Observation can be carried out through data collection tools, such as remote sensing techniques and sensor-based networks. Data can then be stored in digital repositories and shared among the institutions committed to develop an appropriate adaptation strategy.

Analysis and planning. Data is analyzed by scientists and policy makers in a cooperative environment, in order to plan and design sound adaptation strategies. ICT supports the analysis of climate change scenarios through software-based modeling systems, like the ones described in the above paragraph: these tools (e.g. software-based models, Decision Support Systems –DSS- and GIS) facilitate the development of adaptation plans capable to carry out what-if analysis for different sectors on a multi-stakeholder basis.

Implementation and management. The nature of adaptation interventions varies depending on a wide range of elements, such as the set of stakeholders, the sector and the scale of application. As a result, ICT support the implementation and management of adaptation strategies with a wide variety of tools: among the others, forecasting tools, early warning system and resource management systems play a prominent role in this phase.

Capacity building. In this phase ICT can be employed for awareness raising and advocacy (particularly through the use of the Internet), as well as for providing ad-hoc on and off-line training for facing climate change challenges.

Networking. ICTs play a key role in producing, storing, retrieving and comparing information related to climate change issues. This allows both North-South and South-South knowledge sharing and the development of partnerships aimed at facing climate change challenges in different areas of the world.

Monitoring and evaluation. The final stage of every adaptation process is its monitoring and assessment: the performance of the initiative must be constantly verified in order to reach the goal defined during the planning phase. ICT tools provide an effective way to analyze, store and communicate the impact of an adaptation strategy: GIS are likely to be at the forefront of supporting monitoring and evaluation of adaptation strategies, due to their layer-based nature which allows including large geo-referenced information and the related data base.

Conclusion

At present, the majority of applications and systems on climate change issues within the agricultural sector are related to scenario development, impact assessment and adaptation planning. In many of these cases the systems are the result of single Research & Development efforts, rather than collaborative programmes: one of the side effects is a lack of interoperability among different applications. Using an Open Source approach could open the road to the creation of a collaborative community-led environment, as it happened within spatial technology thanks to the Open Source Geospatial Foundation. In addition, it should be underlined that a gap still exists between global and local applications: promoting the development of an integrated framework for information sciences, agro-environmental sciences and communication at different levels is essential in order to fill it. Information is vital to tackle climate change effects: for this reason, a shift is needed in the agriculture sector to disseminate appropriate knowledge at the right time to the ones who are at the frontline in the battle: the farmers, in both developed and developing countries. At the same time, information per se is not enough, but appropriate communication systems are needed to ensure that information come to farmers in an effective, accurate and clear way. This means that the information provided to farmers must have the following properties: timing: farmers need to access to information on time, especially if it implies a change in production strategy; reliability: information must necessarily be correct and comprehensive, including any degree of probability and/or margins of error, in order to result as transparent as possible to the recipient; clearness: indications, to be properly applied, must essentially be created and processed taking into account the recipient' peculiarities, thus adapting the content of the message to his own culture.

In conclusion, any knowledge transfer should take into account farmers' point of view, with the aim of building on their knowledge and capitalize it: climate change is a global problem with local impacts, thus information technology, jointly with communication sciences, can play a big role in blending different perspectives. The evolutions and availability of ICT's hole has been the greatest communications revolution in recent years. The decreasing cost of hardware, increase in reach of communication network and availability of the same at district and below district level is open –up huge potential for agricultural scientists and extension worker to reach the farming community in more focus, precise and specific manner.

References

Sahoo, R.N. 2010. Geoinformatics for Precision Agriculture Lecture delivered in FAI Workshop on 'Fertiliser Reform through ICT'14-17 June 2010 at Kufri Holiday Resort, Kufri, Shimla

Inter-governmental Panel on Climate Change (IPCC), 2007. Climate change 2007: Impacts, Adaptations and Vulnerability. Cambridge University Press, U.K.

NATCOM, 2004. India's Initial National Communication to the United Nations Framework Convention on Climate Change. National Communication Project, Ministry of Environment and Forests, Govt. of India.

Wikipedia (2008): http:// en.wikibooks.org/ wiki/ ICT_in _Education / Definition_ of_Terms

Decision Support System for enhancing agricultural productivity and livelihood security

Dr. Ashutosh Upadhyaya
Head, Division of Land and Water Management

Decision Support Systems (DSS) are a specific class of computerized information system that supports business and organizational decision-making activities. A properly designed DSS is an interactive software-based system intended to help decision makers compile useful information from raw data, documents, personal knowledge, and/or business models to identify and solve problems and make decisions. A Decision Support System (DSS) is basically an umbrella term used to describe any computer application that enhances the user's ability to make decisions. More specifically, the term is usually used to describe a computer-based system designed to help decision-makers use data, knowledge and communications technology to identify problems and make decisions to solve those problems. A Decision Support System (DSS) is actually a collection of integrated software applications and hardware that form the backbone of an organization's or person's decision making process. Individual/Organizations rely on decision support tools, techniques, and models to help them assess and resolve everyday questions. The decision support system is data-driven, as the entire process feeds off of the collection and availability of data to analyze. Business Intelligence (BI) reporting tools, processes, and methodologies are key components to any decision support system and provide end users with rich reporting, monitoring, and data analysis.

Alter (1980) conducted a field study of 56 Decision Support Systems and categorized them into seven distinct types of DSS. His seven types include: (i) File drawer systems that provide access to data items, (ii) Data analysis systems that support the manipulation of data by computerized tools tailored to a specific task and setting or by more general tools and operators, (iii) Analysis information systems that provide access to a series of decision-oriented databases and small models, (iv) Accounting and financial models that calculate the consequences of possible actions, (v) Representational models that estimate the consequences of actions on the basis of simulation models, (vi) Optimization models that provide guidelines for action by generating an optimal solution consistent with a series of constraints, and (vii) Suggestion models that perform the logical processing leading to a specific suggested decision for a fairly structured or well-understood task. Power (2004) reported that data-driven DSS will use faster, real-time access to larger, better integrated databases. Model-driven DSS will be more complex, yet understandable, and systems built using simulations and their accompanying visual displays will be increasingly realistic. Communications-driven DSS will provide more real-time video communications support. Document-driven DSS will access larger repositories of unstructured data and the systems will present appropriate documents in more useable formats. Finally, knowledge-driven DSS will likely be more sophisticated and more comprehensive. The advice from knowledge-driven DSS will be better and the applications will cover broader domains. Arnott and Pervan (2005) traced the evolution of DSS using seven sub-groupings of research and practice: (i) personal DSS, (ii) group support systems, (iii) negotiation support systems, (iv) intelligent DSS, (v) knowledge management-based DSS, (vi) executive information systems/business intelligence, and (vii) data warehousing.

COMPONENTS OF A DSS

DSS is supposed to have three components. The first component is the data collected by a decision maker to be used in making the decision. The second component is the process selected by the decision maker to combine this data. Finally, there is an evaluation or learning component that compares decisions and examines them to see if there is a need to change either the data being used or the process that combines the data. These components of a decision interact with the characteristics of the decision being made. In other words, there are three basic components in a DSS: (i) a database, (ii) a model base and (iii) a user interface. Depending on the system, each of these components may be very simple or highly elaborate. The database, or in advanced systems, a database management system (DBMS) or a data warehouse, consists of structured, real-life information, such as customer account records, product sales history, employee schedules, or manufacturing process statistics. The model base, or model base management system (MBMS), contains one or more models for the kind of analysis the system will perform.

DSS DEVELOPED BY IFDC

In order to improve agricultural yield and livelihood security, IFDC in cooperation with partner organizations has developed and validated number of decision support systems that can enhance decision-making at the smallholder farmer level. Such systems enable rapid assessment of more effective and economic combinations of locally available nutrient sources and inorganic fertilizers that farmers can apply on a site-specific basis. These site-specific recommendations are developed within the framework of an assessment of climate variability and the potential for long-term climate change. IFDC's objectives in relation to decision support tools include:

- The increased awareness of decision support systems designed to help improve agricultural productivity
- The hands-on use of DSTs to address a wide array of production questions
- Enhanced understanding of application opportunities for decision support systems to improve yields and achieve resource conservation

DSTs cover all facets of fertilizer recommendation systems, including risks associated with climatic and market fluctuations. IFDC's array of decision support tools provides a wide range of data and offers critical information on:

- General fertilizer requirements and Integrated Soil Fertility Management (ISFM)
- Use of existing soil, climate, crop and socioeconomic data and crop simulation models for ex-ante analysis of yields and market accessibility for strategic site selection.
- Identifying yield gaps and plant nutrient demand for target yields.
- Determination of optimal nutrient rates within the context of ISFM.
- Designing field trials and data collection exercises.
- Maintaining and updating nutrient recommendations.
- Employing DSTs such as Decision Support System for Agro-technology Transfer (DSSAT) and Phosphate Rock Decision Support System (PRDSS) for rapid analyses and recommendations.
- Application of GIS and Integrated Decision Support System (IDSS) tools for site-specific recommendations.

Decision Support Tools related to various aspects such as Crop modeling, Decision Support System for Agro technology Transfer (DSSAT), Fert Trade, GIS, Market Information Systems (MIS) and Phosphate Rock Decision Support System (PRDSS) were developed by IFDC, which are briefly described below.

Crop Modeling

The assessment and management of agricultural risk takes into account the main sources of annual variability such as weather conditions, the cost of agricultural inputs and the market price of subsequent outputs. To evaluate and quantify front-end environmental and agricultural input risks, IFDC's systems modeling experts developed the Climate Information Analysis Simulation Tool (CIAST).

This tool is a fully functional Geographic Information System (GIS) that interfaces with the Crop System Model within the Decision Support System for Agro-technology Transfer (DSSAT). The integration of climate and geospatial soil databases allows the user a wide range of crop management options for simulation and analysis. To further aid in the decision-making process, CIAST can be combined with a seasonal analysis tool, optimizing annual crop management based on both price/cost structure information and projected climate variability.

With the addition of optional dynamic modules for phosphorus and potassium, the flexible CIAST has been used to test cropping system management in many at-risk agricultural areas around the world. In the last two years, the system has been utilized in the optimization of crop management in India, the southeastern U.S. and Africa, particularly in the nations of Morocco and Benin, with the goal of mitigating risk and maximizing profits.

Decision Support System for Agro-technology Transfer (DSSAT)

DSSAT is a software package integrating the effects of soil, crop phenotype, weather and management options that allows users to ask "what if" questions and simulate results by conducting, in minutes on a desktop computer, experiments that would otherwise consume a significant part of an agronomist's career. DSSAT has been in use for more than 15 years by researchers in over 100 countries. DSSAT is a microcomputer software product that combines crop, soil and weather databases into standard formats for access by crop models and application programs. The user can then simulate multi-year outcomes of crop management strategies for different crops at any location in the world. DSSAT also provides for validation of crop model outputs; thus allowing users to compare simulated outcomes with observed results. Crop model validation is accomplished by inputting the user's minimum data, running the model then comparing outputs. By simulating probable outcomes of crop management strategies, DSSAT offers users information with which to rapidly appraise new crops, products and practices for adoption.

The newest version of DSSAT (Version 4) incorporates changes to both the structure of the crop models and the interface to the models and associated analysis and utility programs. The DSSAT package incorporates models of 27 different crops with new tools that facilitate the creation and management of experimental, soil and weather data files. DSSAT v4 includes improved application programs for seasonal and sequence analyses that assess the economic risks and environmental impacts associated with irrigation, fertilizer and nutrient management, climate change, soil carbon sequestration, climate variability and precision management. DSSAT is one of the principal products developed by the International Benchmark Sites Network for Agro-technology Transfer (IBSNAT) project supported by the U.S. Agency for International Development from 1983 to 1993. It has subsequently continued to be developed through collaboration among scientists from IFDC, the University of Florida, the University of Georgia, University of Guelph, University of Hawaii, Iowa State University and other scientists associated with ICASA.

FertTrade

IFDC's fertilizer trade model, FertTrade, was developed as an analytical tool to evaluate scenarios of changing demographic, economic, technological and agro-climatic circumstances affecting agricultural production. In addition, IFDC economists use FertTrade to forecast and evaluate changes and trends in the global demand, production and trade of nitrogen (N), phosphorus (P) and potassium (K) fertilizer nutrients.

Currently, FertTrade is being used to forecast the potential impact of the development, adoption and use of improved fertilizer N technologies. These technologies will increase the efficiency of nitrogen fertilizer applied to cereal crops from today's average of 40 percent efficiency to 60 percent or higher.

FertTrade can evaluate the impact of a range of "what if" scenarios affecting global markets for N, P and K fertilizer nutrients through 2025. Today's uncertainty about agriculture's capacity to keep pace with rapidly changing demand makes forecasting models – which link such changes with demand for fertilizers–valuable tools for short- and long-term planning of fertilizer production, distribution and marketing.

IFDC will use FertTrade to improve decision-making on policy changes and technology development and transfer to enhance the performance of fertilizer and agricultural sectors at global, regional and national levels. It will be particularly useful in developing countries. Use of FertTrade can produce information that will facilitate the efficient trade of 30-40 percent of the fertilizer nutrients produced worldwide and prevent or minimize shortages and price spikes that may negatively impact fertilizer use and agricultural production.

Fertilizer demand is derived from, and depends on, demand for agricultural products – food, feed, fiber and biofuel. FertTrade analyzes factors that affect the demand, supply and trade of agricultural products–which also affect and determine changes in fertilizer demand. Such factors include national populations and incomes, technological advances in agricultural and fertilizer sectors, climate change and the demand for biofuels.

Geographic Information Systems (GIS)

A geographic information system (GIS) is a technological tool that analyzes and presents information tied to spatial location. IFDC uses GIS to develop maps that help farmers make informed decisions and which support fertilizer recommendation systems. GIS is also used to monitor research and farming sites and gather data such as weather, topography, land use, demographics, economic information and soil type. In agribusiness, GIS can be used to identify locations of suppliers for seed, fertilizer or other inputs, locate the best distribution network, and assess the risk of an area for erosion, drought and flooding. After analysis and evaluation, IFDC updates geographic and attribute databases and exchanges this information with associates in a region or country and/or other agricultural organizations.

GIS also helps IFDC monitor nutrient mining. This allows IFDC to develop guidelines for fertilizer recommendations and strategies for crop production in soil fertility management projects. Much of the geographic information is used to monitor and improve country and regional markets and support fertilizer policies.

IFDC's work with GIS can provide:

- Data creation
- Cartographic products

- Site buffers
- Intersections
- Distance analysis
- Image processing and interpretation
- Join and link data
- Graphs
- Geo-statistical interpretation
- Risk assessment and predictions

Market Information Systems

The lack of accurate and timely market information in the agri-input sector is an issue at continental, regional, national and local levels, and remains a key constraint to the development of agricultural business linkages and trade around the world. Significant progress continues to be made by public and private institutions to implement market information services using advanced information and communication technology (ICT) tools. However, the complexities of fertilizer, seed and crop protection product value chains remain major constraints for integration into broader information systems. In 2008, IFDC conducted exploratory projects in East and southern Africa, subsequently proposing a “road map” to the implementation of a dedicated Agri-Input Technical and Marketing Information System (AMITSA). In West Africa, a similar approach was taken in support of the Economic Community of West African States’ (ECOWAS) effort to build the agri-input components of its regional agricultural information system, the International Information System for the Agricultural Sciences and Technology (AGRIS). Collectively, these MIS tools bring current, relevant and specialized information to the African continent in ways that are highly efficient and effective. With rapidly increasing access to cell phones and computer centers, even the more remote areas of the continent are benefiting from the information offered through this advanced technology.

Phosphate Rock Decision Support System (PRDSS)

Phosphorus is an essential nutrient for crop growth. Phosphate rock is a natural raw material that is a nutrient-rich source for phosphorus. However, reserves are dwindling and conversion of phosphate rock to water-soluble phosphorus fertilizer is inefficient. Thus, it is essential to improve the efficiency of crop uptake of phosphorus directly from phosphate rock. The development of the PRDSS results from 25 years of evaluation of phosphate rock applied to crops in Latin America, Asia and Sub-Saharan Africa. The decision support tool functions with minimal input: soil pH, phosphate rock source and crop species. The PRDSS can also use farm-gate prices to determine which is more economical–water-soluble phosphate or phosphate rock.

DSS RELATED TO LAND AND WATER MANAGEMENT

Rao and Rajput (2009) developed a decision support system for canal water releases (CWREDSS) to provide demand-based optimal canal water releases for reducing the gap between canal supplies and demands for increasing the water-use efficiency in canal command areas. The developed decision support system (DSS) was evaluated under different situations of the command area of Guvvalagudem major distributary of the Nagarjunasagar Left Canal, Andhra Pradesh, India, as a case study. Results indicate that the CWREDSS is capable of developing releases under different scenarios of varying cropping patterns, groundwater use situations and different rainfall probability levels of the study area, and reduced the gap between demands and supplies considerably. DSS provides suggestions/decisions under different situations of water deficit/surplus. CWREDSS will help irrigation engineers, agronomists and agro-meteorologists in the planning, operation and management of irrigation systems.

Upadhyaya et al. (2007) employed OPTALL decision support tool based on quadratic programming technique to minimize the gap between water supply and irrigation requirement and developed optimal as well as equitable water allocation plan for various distributaries to meet the irrigation requirement computed after considering average, 75% dependable and actual rainfall. The optimal water allocation schedule was found much better than actual release and in no case supply demand ratio was more than 1.0, whereas in case of actual release it was excessively higher than 1.0 in many distributaries showing inequitable water distribution.

Upadhyaya et al (2009) developed a Decision Support Tool to explore and promote conjunctive use of surface and ground water in canal command. Through this Decision Support Tool, conjunctive use options in three situations (i) Own tube well (ii) Renting pumping set to run tube well (iii) Purchasing water from tube well owners, can be studied and decision about adoptability of conjunctive use practice in canal command can be taken by farmers. This Decision Support Tool calculates (i) Annual Fixed and operational cost from tube well and canal (ii) Yield and total cost of produce (iii) Excess expenditure incurred in irrigation through tube well over and above canal water charges and (iv) the required rice equivalent yield increase to compensate for the additional cost of irrigation from tube wells. This Decision Support Tool is capable enough of convincing farmers to adopt conjunctive use practices, wherever applicable and beneficial in canal command.

Upadhyaya (2009) developed a 'Beneficial Crop Sequence Selection model' to take decision about beneficial crop sequences. The developed decision support tool is capable to provide information to farmers about suitable crop sequences from benefit-cost ratio, land productivity and water productivity point of view. Since benefit-cost ratio indicates about profitable crop sequence only and does not consider the land and water resources availability with the farmers, this tool provides information about land productivity and water productivity along with benefit-cost ratio and can help farmer to take decision about selection of beneficial crop sequences in a wider perspective.

Upadhyaya (2009) developed Farmer's friendly "Integrated Farming System Components Selection Model" employing Visual Basic Platform. The model is useful in taking decision about selection of integrated farming system components based on expected profit under the prevailing constraints and also to suggest beneficial integrated farming system components not only from profit point of view but also from land and water productivity point of view.

CONCLSIONS

Decision Support Systems are basically tools, which use input data/information and produce output/decision after certain processing based on some set rules/criteria. DSS facilitate users in understanding the impact of various factors/constraints on the system. With the advent of computers, DSS are being developed and used in almost every field. By employing DSS a farmer/planner/policy maker can prioritize the important activities having more impact under existing constraints. DSS in agriculture are also used as convincing tools to explore, suggest and propagate technologies/strategies capable of enhancing agricultural production, income and livelihood security of farmers.

REFERENCES

Alter, S.L. 1980. Decision Support Systems: Current Practice and Continuing Challenge. Reading, MA: Addison-Wesley.

Arnott, D. and Pervan, G. 2005. A critical analysis of decision support systems research, Journal of Information Technology, 20, 2, 2005, 67-87.

Power, D. J. 2004. Decision Support Systems: From the Past to the Future," Proceedings of the 2004 Americas Conference on Information Systems, New York, NY, August 6-8, pp. 2025-2031.

Rao, B.K. and Rajput, T.B.S. 2009. Decision support system for efficient water management in canal command areas. *Current Science*, Vol. 97, No. 1, pp. 90-98

Upadhyaya, A., Wardlow, R., Sikka, A.K. and Kumar, J. 2007. Optimal allocation of canal water for conjunctive use planning. Paper presented in 41th ISAE Annual Convention and Symposium held at JNU, Junagadh, 29-31, 2007.

Upadhyaya, A., Sikka, A.K., Singh, A.K., Bhatnagar, P.R. 2009. A decision support tool to explore and promote conjunctive use options in canal command. Paper presented in Innovation Asia Pacific Symposium 2009, Kathmandu, Nepal from May 4-7, 2007.

Upadhyaya, A. 2009. Beneficial Crop Sequence Selection Model. Paper presented in International workshop on "Water quality research to evaluate the effects of agricultural conservation practices utilized in the United States and India, Allahabad Agricultural Institute, Allahabad, Sept 7-8, 2009.

Upadhyaya, A. 2009. A Decision Support tool to select beneficial integrated farming system components. Annual Report of ICAR-RCER, Patna

ICT for Efficient Water Resources Management

Dr. Adlul Islam
Senior Scientist

Water is the world's most precious natural resource, which is becoming scarce in many parts of the world. The fast growth of the population and the rise in the standard of living aggravated the competition for the limited world's available water resources between agriculture and the other consumers–municipalities, landscaping, recreation and the industry. The UN Comprehensive Assessment of the Freshwater Resources of the World estimates that approximately one third of the world's population was living in countries deemed to be suffering from water stress in 1997 and two-thirds of the world's population would be living in water stressed countries by 2025 (WMO, 1997). The per capita surface water availability in India came down from 4944 m^3 in 1955 to 2309 m^3 in 1991 and 1902 m^3 in 2001. It is projected to reduce to 1465 m^3 and 1235 m^3 by the year 2025, and 2050, respectively under high population growth scenarios (Kumar et al., 2005). By 2050, it is projected that all the basins except Brahmaputra will be below water stress zone and most of the basins will become water scarce.The water scarcity situation for various uses such as agriculture, drinking water, domestic and industrial needs may still become worse, if anticipated impact of climate change on hydrology and water resources are taken into account. Unless timely and properly managed, water scarcity may lead to adverse situation.

Water resource management requires access to a number of data sources, including meteorological data, spatial data such as digital elevation, land use and remote sensing data. The integration of the data sources, together with models of the underlying systems, provide a way in which management decisions on water resources to be determined. Sectoral approaches to water resources development and management have been and still are dominant (Lilburne et al., 1998; Salman et al., 2001) but there is need for a shift towards a holistic approach to avoid fragmented and uncoordinated policies (Rosegrant et al., 2000; Staudenrausch and Flugel, 2001). Systematic evaluation of water management interventions should be performed for a long time horizon, simulating long-run accumulative effects and anticipating potential future changes and uncertainties. Complex integrated modeling can meet those objectives when based on comprehensive information systems. Multidisciplinary information is needed for the analysis of strategies and evaluation of their effects, taking into account economic, hydrologic and environmental interrelationships (McKinney et al., 1999; Bouwer, 2000; Albert et al., 2001).

Information and communication technologies (ICT) cover any product that will store, retrieve, manipulate, transmit or receive information electronically in a digital form. Recently, the use of Information and Communication Technology such as electronic mail (email), mobile communication, teletext, fax, Decision Support Systems (DSS) and the World Wide Web (WWW) has become widespread. One of the biggest benefits of using information technologies in decision-making is the potential to overcome limited resources in terms of time, data, and communication. Applications of information technology are typically particularly effective in solving problems that require significant data processing, and applications in hydrology and water quality are no exception. The interdisciplinary and hybrid work between hydrology and information technology, involving spatial and temporal patterns in physical, chemical, and biological systems and human management, provides significant challenges to achieve the goal of providing relevant, easy to use data, combining approaches that involve geographic information system (GIS) capabilities, databases, and web communication.

Decision Support System
A Decision Support System (DSS) is the Information Technology methodology for supporting decision-making managerial functions and processes; it usually provide model manager that allows creation, updating of data and behavior models that simulates the reality; and has the ability to generate, forecast and evaluate different scenarios and its result. A DSS should also contain a database of a collection of current and/or historical data. Successful DSS should provide both the model manager and the database for the user through suitable interface. Building a successful DSS requires a high level of user participation that's why DSS has been evolved from Desktop into Web and Internet based applications.

The classic definition of a DSS provided by Sprague and Carlson (1982) is "an interactive computer-based support system that helps decision makers utilize data and models to solve unstructured problems." Key terms in this definition are: interactive, data, and models, which are a recurring theme among developers of water management DSSs. DSSs integrate various technologies and aid in option selection for solving relatively large, unstructured problems. Thus, one may think of a Water Resources Management DSS as: *A Decision Support System (DSS) is an integrated, interactive computer system, consisting of analytical tools and information management capabilities, designed to aid decision makers in solving relatively large, unstructured water resource management problems.* Three main subsystems must be integrated in an interactive manner in a DSS (Orlob, 1992): (1) a user-interface for dialog generation and managing the interface between the user and the system; (2) a model management subsystem; and (3) an information management subsystem.

A web-based DSS is a computerized system that delivers decision support information or decision support tools to a manager or business analyst using a ''thin-client'' Web browser like Netscape NavigatorTM or Internet ExplorerTM (Power, 1999).

Components of a Water Management DSS
Decision support systems (DSS) are customized software applications that add value to water resources models and help managers to make informed decisions using information generated by water resources models. A water management DSS would likely consist of the following components:

- *Data Measurement and Collection System* receiving various data (e.g., water level and temperature, precipitation, air temperature, concentrations, etc.) from stations throughout the river basins being managed, as well as weather data and forecasts;
- *Data Processing System* to store the data related to the processes of interest in the basins, both spatial and feature related as well as time series data;
- *Analytical System* of models and tools designed to predict watershed response and provide river forecasts, using data from the Data Collection System, and historical and river basin data needed to calibrate hydrologic models.
- *Decision Formulation and Selection System* for gathering and merging conclusions from knowledge-based and numerical techniques and the interaction of users with the computer system through an interactive and graphical user interface.
- *Decision implementation System* for disseminating decisions regarding water use under normal conditions, and flood warnings, river forecasts, and disaster response in affected areas.

All of these components are inextricably linked, such that the system's effectiveness will be significantly diminished if one or more of the components is not designed and implemented to meet the overall demands of the DSS.

Expert Systems

Consisting of a set of rules and user-supplied data which interact through an inference engine, an expert or knowledge-based system is able to derive or deduce new facts or data from existing facts and conditions. Expert-system shells and programming languages have become widely available allowing users to define databases and rule sets. Some water resources DSS designers have though that expert systems would be a powerful complement to numerical and spatial analysis tools.

Geographical Information System

A **G**eographical **I**nformation **S**ystem (**GIS**) can be defined as a system for entering, storing, manipulating, analyzing, and displaying geographical or spatial data. These data are represented by **points**, **lines**, and **polygons** along with their associated **attributes** (i.e., characteristics of the features which the points, lines, and polygons represent). For example, lines may represent roads, streams, pipelines, or other linear features while polygons may represent vegetation types or land use.

The basic unit in water resources management is the river basin or catchment, and the network of channels, the river network that collects and conveys water. The elements of water resources management are distributed in space. Their location, surrounding, and spatial relationships are critical for the resulting flow characteristics and the quality of the water resources and thus their availability for different types of use. Thus, water resource assessment and management are inherently geographical activities requiring the handling of multiple forms of spatial data. Consequently, geographical information system (GIS) is one of the tools that can be used for their analysis. This makes the use of GIS, and its integration with traditional water resources models, obvious strategy for the development of river basin management systems (Maidment 1993; Fedra and Jamieson, 1996).

Application of GIS in Water Management

Various combinations of geographic information systems (GIS) and simulation models are required for improved understand of water management problems. Geographic information systems (GIS) facilitate to store, retrieve, transform and display spatial data from watersheds or ecosystems (Burrough and McDonnell, 1998). GIS-based watershed resource inventories provide geographic information about soils, land cover, land use management, topography, geology, climate, demographic, socio-economic, and water resources and water quality. Besides mapping of spatial land and water resource data GIS provides algorithms and functions to process and integrate spatial data GIS offer powerful tools for the collection, storage, management, and display of map-related information. Simulation models provide decision-makers with interactive analysis tools for understanding the physical system and judging how management actions might affect that system.

Traditional watershed delineation has been done manually using contours on a topographic map. A watershed boundary can be sketched by starting at the outlet point and following the height of land defining the drainage divides using the contours on a map. The advent of Geographical Information Systems (GIS) has significantly increased the speed and accuracy with which a hydrologist can determine the divide of a watershed. Most GIS have a suite of functions that operate on a raster map of elevation to identify all the pixels that could potentially, under gravity driven flow, drain through a user selected target pixel (usually called the pour point/seed point or outlet point). In the field of watershed management GIS can be effectively used for: (a) studying the characteristics of watershed and catchment areas to gain better insite into the water inflow to rivers and basins; (b) understanding the topological relationships between drainage patterns, land use, soil type and land cover of the catchment area; (c) formulation of plans for hydroelectric projects; construction of storage reservoirs by studying drainage patterns.

GIS has played a major role in the development of distributed hydrologic models and in improving our understanding of the spatial aspects of the distribution and movement of water in landscapes. Hydrologic models originally developed assuming watershed to fairly homogenous, allowing weighted averages to be used as inputs. These models generally use spatially averaged or mean values to describe watershed characteristics such as soil type, slope and land use. On the other hand distributed parameter models account for heterogeneity and spatial variability by considering variation in watershed characteristics across the entire area of watershed, and provide detail description of the hydrological process in a watershed to satisfy various needs in spatial modeling (Abbott and Refsgaard, 1996). Hydrological modeling at the basin scale using distributed hydrological models requires large input data to describe the spatial variability of watershed characteristics. Manual collection of input data for such models is often difficult and tedious due to level of aggregation and the nature of spatial distribution. GIS has been proven to be an excellent tool to aggregate and organize input data for distributed parameter hydrologic models (Srinivasan and Arnold 1994). Recent progresses in remote sensing technology and computer science have improved the availability of hydrological data and computing resources. Numerous kinds of hydrologically relevant data, especially spatial information, can be derived from remotely sensed information. Utilizing distributed hydrological models and the remotely sensed data require powerful and user friendly data processing hardware and software. Geographic information systems (GIS) have been proved to be very useful in handling vector and raster data. GIS provide the means to geo-referenced data which enables the classification, overlaying, mosaicking, data manipulation and visualization of the data. The capability of GIS to produce high quality maps incorporating model output and geographic entities provides visual support and aid in decision making process. Maidment (1991) identified four distinct application of GIS in hydrology: hydrological inventory and assessment, hydrologic parameter determination, hydrologic model set up using GIS (loosely coupled GIS and hydrological models), and hydrologic modeling inside GIS (integrated GIS and hydrological models). Parameter estimation involves determination and quantification of input to hydrologic models through the manipulation and analysis of terrain-related data sets, where GIS has been widely used in hydrology. Thus, GIS have provided new opportunities to develop and run fully distributed models efficiently.

References:

Abbott, M. B.and J. C. Refsgaard (1996). Distributed hydrological modeling. Kluwer, The Netherland.

Albert, X., O, Mark, M. S. Babel, A. D. Gupta, and J. Fugl (2001). Integrating Resource Management in South East Asia, *Water21 October 2001*, 25-30.

Bouwer, H. (2000), Integrated Water Management: Emerging Issues and Challenges, *Agricultural Water Management*, 45, 217-228.

Burrough, P. A. and R. McDonnell (1998). Principles of Geographic Information Systems. Oxford University Press, London, UK

Fedra, K., and D. G. Jamieson (1996). An object-oriented approach to model integration: a river basin information system example. In: Kovar, K. and Nachtnebel, H.P. [eds.]: IAHS Publ. no 235, pp. 669-676.

Kumar, R., Singh, R.D. and Sharma, K.D. (2005). Water resources of India. Current Science, 89(5): 794-811.

Lilburne, L, J. Watt, and K. Vincent (1998). A Prototype DSS to Evaluate Irrigation Management Plans, *Computers and Electronics in Agriculture*, 21, 195- 205.

Maidment, D. R. (1991). GIS and hydrological modeling. Proc. 1st Int. Symp./Workshop on GIS and Environmental Modeling.

Maidment, D.R. (1993). GIS and hydrological modeling. In: M.F. Goodchild, B.O. Parks and L.T. Steyaert [eds.] Geographic Information Systems and Environmental Modeling. Oxford University Press.

McKinney, D.C, X. Cai, M. W. Rosegrant, C. Ringler, and C. A. Scott (1999). Modeling Water Resources Management at the Basin Level: Review and Future Directions, *International Water Management Institute*, SWIM Paper 6.

Orlob, G. 91992). "Water quality modeling for decision making," J. Water Resour. Plann. and Manage., 118(3), 295-307.

Power, D.J., 1999. Decision Support Systems Glossary. DSS Resources, World Wide Web, http://DSSResources.COM/glossary/. Accessed October 2001.

Rosegrant, M.W., C. Ringler, D. C. McKinney, X. Cai, A. Keller, and G. Donoso (2000). Integrated Economic-Hydrologic Water Modeling at the Basin Scale: the Maipo River Basin, *Agricultural Economics*, **24**, 33-46.

Salman, A.Z., E. K. Al-Karablieh, and F. M. Fidher (2001). An Inter-Seasonal Agricultural Water Allocation System (SAWAS), *Agricultural Systems*, **68**, 233-252.

Sprague, R., and E. Carlson (1982). "Building Effective Decision Support Systems," Prentice Hall, Englewood Cliffs, 1982

Srinivasan, R. and J. G. Arnold (1994). Integration of basin scale water quality model with GIS. Water Res. Bull., 26(4):611-620.

Staudenrausch, H. and Q. A. Flugel (2001). Development of an Integrated Water Resource Management System in Southern African Catchments, *Phys.Chem. Earth*, **26**, 561-564.

WMO (1997). A Comprehensive Assessment of Freshwater Resources of the World. World Meteorological Organization (WMO), Geneva.

Information and Communication Technology in Aquaculture

Alok Kumar Jain
Senior Scientist (Fisheries)

Aquaculture is a livestock-rearing business that has developed and grown considerably during last three decades in India in terms of seed production and multi-species aqua-culture. Besides, sea-food supply to South East Asian and European countries and America has increased tremendously. A little background on the aquaculture and fisheries sector's history is, without doubt, necessary. The main reason for the people to invest in aquaculture is to make a profit from this farming or capture fishery activity and, historically, the freshwater carp and trout sectors were the main professional elements of commercial fish farming. These developed slowly at the beginning of the 7th decade of 20thcentury where young fish stocks were conventionally reared in ponds or tanks. The development of transportation technology allowing movement of fry and fingerlings from hatcheries to on-growing farms, combined with the industrial manufacture of pelleted feeds, led to a very rapid expansion of the sector's production in the 1980s. During this period, carp farming developed rapidly. In addition, growing market-size prawns and shrimps also became a viable commercial activity. In the 1980s, viable hatchery technology was developed for the production of Indian major and exotic carp fish seed. This opened the way for the development of commercial fish farming in India. Consequently, the aqua-culturists, for the application of information and communication technology, are of differing background, geographically dispersed and have varying topics of interest. In addition, the fish farmers do not have the possibility of landing their catch at a port with the infrastructure for sales & distribution. It is these sectoral characteristics that make the modern Information Communication Technology ideally suitable and even essential for the sector's future.

ICT Priorities of the Aquaculture Sector

Production Aspects

Commercial aquaculture requires good technical and financial management, where production monitoring and efficiency is a key element. For example, feeds represent one of the major inputs in the business and accurate data on stocks and other parameters are needed in order to manage efficiently and minimize waste. All farmers are looking for optimal growth at the lowest cost and a number of increasingly-sophisticated mathematical computations are currently available for this purpose, allowing much improved operational planning to be achieved. Analyzing production data to provide accurate harvest forecasting is without doubt one of the keys to operating a successful modern farm. Seasonal demand and price fluctuations are common for many fisheries and aquaculture products but where aquaculture should have the significant advantage of being able to plan production and harvest rather than rely on the variant conditions encountered by capture fisheries.

Marketing Aspects

Increasingly sophisticated sales and marketing strategies are required. In order to earn maximum profit, processing activity by many aquaculture companies has increased significantly and these companies, by and large, abide to the consumer safety laws and HACCP requirements. Although one often refers to 'added-value' products from processing, the absolute need to respond to the consumer's wishes and desires infers, particularly in Urban India, that packaging and processing have become a means to sell rather than an option. Consequently, part of the production sector has moved towards processing in order to get 'closer' to the consumer; by manufacturing a product that can be sold to a retailer, the chain of intermediaries has been reduced. Companies investing in this part of the business no longer need to pass through the traditional supply lines of Wholesale to Processing (optional) to retail Marketing, thus reducing the Distribution logistics and costs associated with these sectors. Individual or co-operative investments in this sector are now responsible for a large part of the sales of aquaculture's products, adapting to and evolving with the modern market's requirements. Evidently, traditional IT products for business management are considered essential within such an environment.

Information Requirements

In summary, the Indian aquaculture characteristics include:

- wide geographic dispersion (all around the country, coastal and inland, freshwater, brackish-water, coldwater)
- production specialization (mono- or multi-species)
- production limitations (site licenses limiting production)
- distance from major markets

There is a recognized need for accurate, trustworthy and readily available market information since this is required for both short and medium term planning of production, harvesting, processing and sales. Consequently, the real and potential facilities provided by information technology and electronic communication are being integrated into the sector, though slowly. A personal estimate is that persons in aquaculture businesses rarely use the Internet and that those users are only relatively large companies. The evident cost benefits of using the Internet for information communication has moved on from being technically led to being market-led. Simpler user technology and immediate results are the most convincing argument to attract those involved in the production sector. Busy technical and sales-staff do not have the time to 'surf' the Internet; they want to find the information that they want or need, quickly & efficiently. If the service is good, they will use it. There is considerable hope for the application of electronic information and trading mechanisms that would help the smaller rural and/or coastal producer to be able to benefit from the concept of the shorter distribution chain described. The challenge of using direct communication lines between the seller and the buyer, who is at the closest point to the consumer, probably represents the only way in which a producer will be able to make an adequate profit margin while selling at a real market value. This would be because the costs charged by intermediaries would not be passed down and added to his 'ex-farm' price. The reality of this situation, referring particularly to declining prices and increasing costs, is evident to those working within the sector. The Internet now provides low-cost and efficient communication where developments in data encryption and electronic payment facilities, are providing an increasingly safe desktop environment for conducting business. When these factors are combined with adequate information services for technical and marketing data, the scene is being set for the most significant leap forward in efficiency that the sector could hope for.

Uses of ICT in Current Aquaculture

In this background, following are ICT requirements for the real progress of the aquaculture sector:

1. For farm management, there is a need of proprietary stock management and forecasting programs for facilitating the tasks of daily operations and, functioning as unique databases which can be communicated electronically and centralized for

separate growing units or farms. As these programs improve, significant improvements in farm performance and management will be achieved.

2. Centralized communication on technological developments should be developed whose goals should include the rapid dissemination of the results of research in the field directly to the farmer, using both paper and electronic supports.
3. Market and production data information should be made available by the central agency through its network of Member Associations. The goal of this action is to provide the farmer with better accurate data. This is to enable him to sell from the strength of being well informed.
4. Several dedicated Internet sites have been established for information and communication on aquaculture, ranging from the academic to the industrial. In developed countries, some of these sites are communicating offers (supplies or demands). Similar network for Indian farmers is the essential need.
5. The use of 'Extranets' where privately operated networks can be accessed for communication and trading purposes is probably the next step forward for the aquaculture sector.
6. However, the developments surrounding the technology of electronic commerce is one of the most interesting and exciting developments that is foreseen for the sector.

There are many questions that remain to be answered on a practical level. The most evident ones include guaranteeing quality for 'blind' sales and the problems of logistical organization for distribution. There is no doubt that the ICT technology will allow the creation of 'virtual' organizations, and many such organizations working through a common channel will become a reality. But, the key issue will remain creation of confidence in the production sector to use this technology within a highly competitive business environment. Many of these technological developments are not being used by the professional sector, simply because there is a definite lack of knowledge of how to use the Internet, what it involves and what it could do for business. For this reason, there is a need for developing an introductory course for farmers, presented by users rather than developers. At this time, it is essential to bridge the gap between those who are trying to develop 'systems' and those who could use them. The realization of the potential offered by ICT will only be successful if the users are aware of and will use the systems proposed. The sustainability of services that provide information and contacts has been open to question, particularly when many information providers find it difficult to warrant or justify payment for reading one or two pages. Consequently, these information suppliers depend on grants, advertising revenue or their site is an introduction to other commercial items (newsletters, product catalogues *etc*.). The development of secure payment systems for low-cost items should stimulate a more competitive and constructive market for ICT services than has existed to date.

Conclusion

There are many identifiable subjects that are appropriate for ICT and from which the aquaculture sector could benefit but if these projects are to succeed, the following criteria should be respected:

- Clear and focused services
- Simple and user-friendly
- Accurate information
- Well organized and easy to find

Closer co-operation between developers and industry operators has to be stimulated in order to encourage real progress. It is important to avoid dispersion and distancing from the wishes and desires of the end-user in this development phase.

Bioinformatics Tools for improving agricultural productivity

R. Elanchezhian
Sr. Scientist, Plant Physiology

Biology has undergone several rounds of transformation in terms of the research paradigms it has operated, ranging from theoretical to experimental, in the pursuit of discovering new molecular mechanisms that regulate biological form and function. In the decades to come, it will take on another transformation to understand the modes of action of biological processes at the organismal level, where computational models of systems-wide properties could serve as the basis for prediction of biological behavior, leading to new experimentation and discovery. For this transformation to occur, it is essential to facilitate and enhance the processing, integration, and interpretation of the massive amounts of biological data by the life science research community. Bioinformatics is a collective name used for computer science based approaches in fields such as molecular biology, biotechnology, medicine and agriculture. Broadly it includes the application of modern computers, telecommunications, networks, and databases, as well as more specialized tools such as GIS, image analysis, and statistical and modeling software. This includes database development, data management, software (algorithm) development, modeling (simulation), and quantitative analysis. Bioinformatics is a fast-emerging branch of biological sciences which has reduced the lead time for various processes involved in the chain of biotechnology research and developments like assignment of the gene/ protein function, locating of the similar gene sequences in different organisms, selection and online testing of the potential drug targets and so on. Growth of bioinformatics has accelerated particularly during the last decade due to path breaking advancement in biology and new technologies that produce huge data like high throughput full genome sequencing projects including the human genome and other genome projects. The data mining and analysis of such large data and extract of knowledge from this data is being made possible only with the help of new software tools and computational intensive techniques. The researchers need to learn and use all new technological developments which are taking place in bioinformatics to solve complex biological problems leading to advancement in health care and crop improvement systems to facilitate overall growth and improvement. In nutshell, Bioinformatics is conceptualizing biology in terms of molecules and applying informatics techniques to understand and organize the information associated with these molecules, on a large scale. In biology/ agriculture, bioinformatics is being useful in the following aspects.

- Overwhelming amount of data are being collected and stored and analyzed using highly efficient, fast and productive technology of genomics
- The primary genomic data types are DNA and Protein sequence, genetic mapping data and data resulting from functional analysis. Most of them are freely available to public via internet and World Wide Web.
- Information technology support systems are used for management of molecular experimental bibliographic and other biological and environmental data
- There is a Need to share data among researchers, policymakers and the general public, which is made possible by Internet, www and digital library technology

Biological data includes:

Nucleotide and amino acid sequences, protein structure data, protein-protein interaction data, protein-DNA interaction data, data on enzymatic and biochemical pathways, webs of neurological structures and pathways, population-scale data, large-scale gene expression data, ecological and environmental data, satellite data, large-scale weather and soil data. Thus, bioinformatics provides information synthesis capabilities, large capacity computational systems and other infrastructure and tools for the documentation and analysis of accumulated data and knowledge. There are three main types of biological databases that have been established and are being developed- large-scale public repositories, community-specific database resources, and project-specific databases- although the lines among these categories are becoming less clear. Large-scale public repositories are usually developed and maintained by government agencies or international consortia. Examples include GenBank, which is an international nucleotide sequence repository developed and maintained as a collaboration between the National Center for Biotechnology Institute in the United States, EMBL in Europe, and DDBJ in Japan. Other examples include UniProt (Schneider et al., 2005) that stores protein data and ArrayExpress that stores microarray data. There are a number of community-specific database resources, a key example being model organism databases that cater to researchers focused on specific model species such as maize (*Zea mays*; Lawrence et al., 2005), Medicago (Cannon et al., 2005), rice (*Oryza sativa*), and Arabidopsis (*Arabidopsis thaliana*). The concept of community specific databases is subject to change as researchers are widening their scope of research. For example, the explosion of available sequence data from many organisms has enabled researchers to more readily compare sequences of interest from many different species in combination with a number of model organism databases. In addition to databases focused on a single species, databases that deal with taxonomically related species have emerged recently, which include databases for cereals and grains. Other examples of community-specific databases include those that are focused on specific classes of data, such as metabolism (Zhang et al., 2005), genome annotation (Yuan et al., 2005), orthologous relationships (Horan et al., 2005), and germplasms. The third category of databases includes smaller-scale and often short-lived databases that are developed for the management of project data during the funding period. Often these databases and Web resources are not maintained beyond the funding period of the project, and currently there is no standard way of depositing or archiving these projects or the data stored within. The preservation and ongoing availability of such information requires a clear solution, and innovative and creative methods and technologies.

Databases and software used in Bioinformatics

Molecular Modelling: 1. Chimera 2. Arguslab 3. Dock 5 4. Modeller (version 6.2 & 8.1)

Visualization tools: 1. Ras Mol 2. Swiss PDB viewer 3. 3D Molecular viewer 4. AnTheProt 3D viewer 5.Cn3D 6. YASARA 7. YCM Browser

Sequence analysis: 1. GeneDoc 7. A.I.O

2. Wingene 8. Sequencher

3. Winpep 9. CLC work bench 3

4. DNA for window 10. Bioedit

5. DNASIS 11. BLAST

6. Clustal x 1.8

***In silico* Cloning tools**

1. Gene Construction kit 2. Vector NTI 9.1 (Demo)

3. Sim Vector 4. OMIGA (demo)

5. Plasmid draw 3.2 6. Redasoft

7. CloneMap (demo)

Gene annotation Tools

1. Gold MINER 2. Genome browser

Primer Designing tools

1. Primer premier 5.0 2. Primer

Phylogenetic Analysis

1. Tree View 2. Phylip 3. MEGA

Web Designing Tools

1. PHP Designer 2005 2. PHP 5.2 3. Dream weaver 8 4. DB Designer 4

5. Apache web server

RDBMS

1. ORACLE 9i 2. My SQL 5.0.18 – win32

The lecture / training will help enable the participants to

- Gain knowledge on internet resources for Agricultural Biotechnology.
- Learn how to use public molecular databases for DNA and Protein sequence analysis.
- Comparison of DNA and protein sequence by using BLAST and Clustal X.
- *In silico* Protein structure modeling by using the software Modeller 6v2.

Farmers' advisory services using ICTs for enhancing agricultural productivity

Ujjwal Kumar
Senior Scientist, Agril.Extension

The Second Green Revolution of boosting food-grain harvest in India to 400 million tons by the end of the year 2020 is need of the day. Its achieving is not a herculean task if farmers embrace latest technology suited to the area. Here, challenges lie in availability of advisory services (knowledge, information, linkages etc.) to the resource poor farming community as and when required suited to their own situation. Now, extension or advisory services are more diversified, more technology intensive and more demand driven which makes more difficult for the extension worker or the organization working for the vast and diversified farming community without proper networking. India has made remarkable progress in the field of Information and communication technology (ICT) that could be put to effective use for delivering advisory services to the needy farmers. In other word the information and communication tools are reducing dependency for personal advice and the farmers and extension workers are suppose to use one or another tools of ICT to acquire desired information and services. The most widely used and available tools of farmers' advisory services are- telephone based Tele Advisory Services, the mobile based Agri Advisory services, television and radio based mass media programms, web based online Agri Advisory services, video-conferencing, Online Agri video Channel, besides traditional media like, printed literature, newspapers, farmers exhibition/fair etc. The farmers or extension workers can choose any medium to seek the relevant information and advice. Majority of farmers want information with respect to –crops (varieties, package of practice, plant protection etc.), planting material availability, soil,agrimarket information, weather information, Information on agriculture allied activities like dairy, poultry, beekeeping ,mushroom etc. along with information about marketing of the products, credit facility, incentives, Government policies and schemes, supportive measures like subsidies etc.

Most of the agricultural institutes and organizations have their own telephone based advisory services for farmers which provide telephone based Agri advisory services through a dedicated telephone number to provide real-time information and advisory. The on-line phone based expert advice service, Kisan Call Centres (KCC), launched by the Ministry of Agriculture, Government of India is available for all within the country since January 2004.A toll-free telephone number "1800-180-1551" has been provided that is operational on all days from 6.00 am to 10.00 pm. Beyond these hours the calls are attended in the Interactive Voice Response System (IVRS) mode. The KCC consists of three operational levels. Level– I is the basic Call Centre interface by local language proficient agricultural graduates who picked up the calls with a short welcome message. In case the level I expert is not able to answer the question, he forwards the calls to the concerned Level –II experts. The level –II experts are the Subject Matter Specialist (SMSs) located at Resource Centres in SAUs, ICAR institutes/ Departments. Level III is the management group that ensure the ultimate response and resolution of all queries (mainly policy matters) not resolved by either L-II or L-I.

The mobile based Agri Advisory services offers text, voice and video content based Agri information services through mobile phones. Mobile phones are becoming an essential device for all types of users irrespective of the age group. In India mobile technology has unleashed a paradigm shift in the communication medium to reach out to the masses. KISSAN Kerala, an integrated, multi-modal agricultural information system, provides several dynamic and useful information and advisory services for the farming community across the state of Kerala. Mobile based service has been established to provide text, voice and video based information services. It offers several services like crop advisory, weather forecast, soil test information etc through farmers mobile. Similarly, “m KRISHI” developed by Tata Consultancy Services Ltd (TCS) ,IFFCO Kisan Sanchar Ltd. (IKSL) are also providing mobile based advisory services for farming community. Advantages of these services are that those are location specific, reliable and cost effective.

Community radio is one of the important tools of ICT that offer farmers and the people a voice and help development of the community. Community radio is owned and operated by a community or members of a community.On 16 November 2006, the government of India notified new Community Radio Guidelines which permit NGO and other civil society organizations to own and operate community radio stations. By August, 2010, 233 Letters of Intent were issued by the Ministry of Information & Broadcasting, Government of India and Grant of Permission Agreements were signed with 110.Presently, the number of operational community radio stations in India is 82 (19 NGOs,55 Educational institutions,05 Agril.univs and 03 KVKs). Television channels like Doordarshan (DD) and Etv are telecasting agriculture related programmes regularly in regional languages. Weekly KISSAN-KRISHIDEEPAM TV programme through Asianet channel is popular in Tamilnadu. Similarly, other satellite channels are also broadcasting useful progranmmes for the farmers to suit their local needs.

Success Cases

ITC’s Agri Business Division launched **“e-Choupal** “ in June 2000 in which village internet kiosks managed by farmers - called *sanchalaks* - themselves, enable the agricultural community access ready information in their local language on the weather & market prices, disseminate knowledge on scientific farm practices & risk management, facilitate the sale of farm inputs (now with embedded knowledge) and purchase farm produce from the farmers' doorsteps (decision making is now information-based). Real-time information and customized knowledge provided by 'e-Choupal' enhance the ability of farmers to take decisions and align their farm output with market demand and secure quality & productivity. The aggregation of the demand for farm inputs from individual farmers gives them access to high quality inputs from established and reputed manufacturers at fair prices. As a direct marketing channel, virtually linked to the 'mandi' system for price discovery, 'e-Choupal' eliminates wasteful intermediation and multiple handling. Thereby it significantly reduces transaction costs. ‘e-Choupal', has already become the largest initiative among all Internet-based interventions in rural India. 'e-Choupal' services today reach out to over 4 million farmers growing a range of crops - soyabean, coffee, wheat, rice, pulses, shrimp - in over 40,000 villages through 6500 kiosks across ten states (Madhya Pradesh, Haryana, Uttarakhand, Karnataka, Andhra Pradesh, Uttar Pradesh, Rajasthan, Maharashtra, Kerela and Tamil Nadu. ***e*-Sagu**, an ICT based personilzed agro-advisory system is being developed since 2004.The The word 'Sagu' means 'cultivation' in Telugu language. It aims to improve farm productivity by delivering high quality personalized (farm-specific) agro-expert advice in a timely manner to each farm at the farmer.s door-steps without farmer asking a question. The advice is provided on a regular basis (typically once a week) from sowing to harvesting which reduces the cost of cultivation and increases the farm productivity as well as quality of agri-commodities. In eSagu, the developments in IT such as (database, Internet, and digital photography) are extended to improve the performance of agricultural extension services. The eSagu system offers next generation agro-advisory tool, and supplements and integrates into the existing agricultural extension system. In e-Sagu, rather than visiting the crop in person, the agricultural scientist delivers the expert advice by getting the crop status in the form of digital photographs and other information. The eSagu system contains the following parts: (i) Farmers (ii) Coordinators (iii) eSagu local center (iv) Agricultural information system and (v)

Communication system. The farmers are the end users of the system and can be illiterate. A coordinator is an educated and experienced farmer who is stationed in the village. Each coordinator is attached to eSagu local center which contains few computers and a computer operator. Agricultural Experts possess a university degree in agriculture and are qualified to provide expert advice. Agricultural Information System is a computer based information system that contains all the related data. Communication system is a mechanism to transmit information from farms to agricultural experts and vice versa. If enough bandwidth is not available, photographs from the village to the main system can be transmitted through courier service. However, the advices (text) can be transmitted from the main system to the local center through dial-up Internet connection.

AKASGANGA (Meaning “milky way” in hindi) was established in 1996 under the banner of Shree Kamdhenu Electronics Private Ltd. (SKEPL) by a group of young entrepreneurs. It was established at a time when information technology was almost unknown in the villages of India. AKASHGANGA’s success demonstrates the potential of information technology to impact livelihoods in poor, rural communities. AKASHGANGA’s experience indicates that even illiterate or semi-literate people can adopt IT-based systems when they see substantial benefits and when the systems are deployed in purposeful, easy-to-use ways. SKEP L’s experience also indicates that providing direct benefits and expanded opportunities to poor communities in developing countries can be profitable. AKASHGANGA, in tying its future to improving the productivity of its customers, will succeed to the extent that it can help transform the fortunes of rural dairy farmers, demonstrating the synergies between business and development goals. All the members (farmers) (members) of the Dairy Cooperative Society DCS congregate twice a day at its premises to sell milk. Previously all the milk collection activities were performed manually. Due to the climatic conditions, milk would often get spoilt, as producers had to wait in long queues. Secondly, the payment for the milk sold would get held up. The simple technology used in this product has enabled the timely collection of milk and thus, generated higher earnings for the producer, now paid well in time. A basic milk collection transaction done by AKASHGANGA comprises : Automatic milk collection system, an electronic weighing scale, a dairy information system kiosk, and a milk analyzer that tests for levels of fat and non-fat milk solids. Capture of unique member ID by the PC software ·Multilingual printing of payment slip.SKEPL also offers accounting and milk procurement software, as well as consulting and maintenance services, to its customers. The company’s products and services are competitively priced, keeping in mind the limited purchasing power of its customers. Currently, the majority of the company’s customer base is in the states of Gujarat and Maharashtra.

KISSAN (Karshaka Information Systems Services and Networking) **Kerala-**is an integrated, multi-modal Agricultural information system, which provides several dynamic and useful information and advisory services for the farming community across the state of Kerala. The core deliverable and achievements of the project is an integrated multi-component, multi-modal delivery of Agriculture Information Services system that is accessible anywhere anytime by all concerned. The project adopted a strategy of providing right information to the right people in the right context and empowers the farmers with adequate knowledge, which helps them to take better decision. The project solves the problem of content gaps by providing the authentic agricultural information though various delivery methods like Television, Internet, Telephone, and Mobile. The farmers may choose any medium to seek the relevant information. The project offers the following major services: (A). Online Agri advisory service: The dynamic portal based online Advisory services for the farmers (www.kissankerala.net) (B). Kissan Krishideepam: Agriculture based weekly Television program - in local language through Satellite channel (C).

Online Agri video Channel: The project has launched the country's first online video channel in Agriculture in collaboration with YouTube (D). Tele Advisory Services: The project also provides telephone based Agri advisory services through a dedicated telephone number (E). The mobile based Agri Advisory services: The project offers text, voice and video based contents and Agri information services through mobile phones. The project has answered more than 18000 questions of farmers through online using the query management service of the portal. The project has generated 32225 online soil test based fertiliser recommendation advisory for farmers and distributed to the farming community during the last one year. The project has completed the production and telecast of 348 weekly episodes of television based agricultural program through Satellite channel. The program reaches to more than 46 lakhs regular viewers every week. The project has produced more than 1000 hours of digital quality video materials on best farming practices, success stories of farmers, women groups, technical information, method demonstration, organic farming etc. The digital archive is made available to farming community as part of knowledge sharing. Launched country`s first dedicated online video channel on Agriculture in collaboration with Google/YouTube and uploaded more than 150 videos. It has launched an integrated mobile based Agri advisory services by integrating text, voice and video based contents. The project has won several Awards and recognitions during the last several years. Some of the major recognitions are. (1). e-India National Award 2009: Best ICT enabled Agriculture Initiative of the Year (Jury Choice Award) (2). Manthan Award South Asia - 2008 for Design and development of integrated, multi-modal agricultural information system for Kerala (3). First Kerala State e-Governance Award: 2009 for effective online services.

Table 1: A list of Major ICT initiatives for farmers

Name	Implementing Agency	Sponsoring Agency	Target groups/Area	Year of Starting	Mode of Information
Government/ Public Sector initiatives					
ASHA	National Informatics Centre	Dept. of IT, Govt. of India	North east	2001	Internet
Agriculture Technology Information Centre (ATICS)	ICAR,SAUs	ICAR	India	2001	Internet,Mobile/telephone
AGMARKNET	National Informatics Centre (NIC) (GOI)	Directorate of Marketing and Inspection (DMI) - Ministry of Agriculture	India	2001	Internet
AGRISNET (Agricultural Informatics and Communications Network)	NICNET	Indian Council of Agricultural Research ICAR	Rural areas of India	2002	Internet

Bhoomi	Revenue department, Government of Karnataka	Government of Karnataka	Farmers of Karnatka	2004	Internet
Bhu-bharti (Integrated Land Information System)	Revenue department, Government of Andhra Pradesh	Government of AP	Farmers of AP	2005	Internet
Bhu-rekha (Land records information system)	Revenue department, Government of Kerala	Government of Kerala	Farmers of Kerala	2006	Internet
Community Information Centres (CICs)	National Informatics Centre(NIC) and National Informatics Centre Services Incorporation(NIC SI	Ministry of Development of North Eastern Region	Rural population of Arunachal Pradesh, Manipur, Assam, Meghalaya, Mizoram, Sikkim, Tripura, Manipur and Nagaland	2002	Internet
Community Radio - Deccan Development Society	Deccan Development Society	UNESCO	Dalit women of Medak District, AP	1998	Radio
Digital Mandi	Media Lab Asia	Media Lab Asia & IIT Kanpur	India	2003	Internet
e-Sagu	International Institute of Information Technology, Hyderabad	Ministry of Communication and Information Technology, Govt. of India	Farmers India	2004	Internet
e-Arik	College of Horticulture and Forestry, Central Agricultural University (CAU)	Department of Scientific and Industrial Research (DSIR), Ministry of Science and Technology, Govt. of India	Tribal farmers of India	2007	Internet, TV, Telephone/mobile

e-KRISHI VIPANAN	Madhya Pradesh Agricultural Marketing Board (Mandi Board) and Madhya Pradesh Agency for Promotion of Information Technology (MAP_IT)	Govt. of Madhya Pradesh	Madhya Pradesh	2003	Internet
E-gram	Govt. of Rajsthan/Gujrat	Govt. of Rajsthan/Gujrat	MP/Gujrat	2009	Internet
Entegramam	KSITM	UNESCO	Kerala	2008	Intenet
Gender Resource Center (GRC)	Women Cell of Directorate of Extension, Department of Agriculture & Cooperation, Ministry of Agriculture (GoI)	Govt. of India	India	2004	Internet
Gram Vani	IIT Delhi	Govt & Knight Foundation	North India	2008	TV, Radio Internet, Mobile
Gramin Gyan Kendra	Media Lab Asuia & Institute Of Technology BHU Varanasi	Media Lab Asia, Ministry of Information Technology, Govt. of India	North India	2006	Kiosk
Grasso PCO Project	GRASSO	GRASSO, Dept. of IT - Govt. of West Bengal	West bengal	2003	Mobile, Kiosk
Gyandoot	Govt. of MP, NIC	Govt. of MP	MP	2000	Internet
I Kisan	Nagarjuna fertilizer & chemical Ltd, Hydearabad	NFCL	India	2004	Internet
IFFCO Kisan Sanchar	Airtel & IFFCO Kisan Sanchar	IFFCO Kisan Sanchar Ltd.	India	2008	Mobile

Kisan Soochana Kendra (KSK)	Jai Kisan/IIT Roorki	UNDP, Dept. of IT – Govt. of Uttaranchal, NIC Uttaranchal	Farmers of Uttarakhand	2005	Internet/ mobile
Kisan Call Centres	Department of Agriculture & Cooperation (DAC), Ministry of Agriculture, Govt. of India	DAC	Farmers India	2004	Telephone/mobile
KISSAN-Kerala	Indian Institute of IT and Management (IIITM-K)- Kerala	Dept. of agriculture, Govt. of Kerala	Farmers of Kerala	2003	Internet, TV, Telephone/mobile
Village Resource Centres (VRCs)	Satyabama Universit;Chennai, Indian Space Research Organisation (ISRO	Indian Space Research Organisation (ISRO), M S Swaminathan Research Foundation (MSSRF)	Tamilnadu	2004	Internet
Private Sector initiatives					
Agriwatch Portal	Indian Agribusines Systems Pvt. Ltd. (IASL)	IASL	Farmers, traders, processors of agricultural outputs, suppliers of agricultural inputs etc	2001	Internet
AKASHGANGA	Shree Kamdhenu Electronics Pvt Ltd	Shree Kamdhenu Electronics Pvt Ltd	Dairy farmers of Gujarat & Maharashtra	1996	Internet
i-Shakti	Unilever, e-Seva and other NGOs	Hindustan Unilever Ltd.	Women & Youth of Andhra Pradesh	2004	Kiosk , Internet
ITC eChoupal	ITC's International Business Division (IBD	ITC's IBD	Farmers of Madhya Pradesh, Haryana, Uttarakhand, Karnataka, Andhra Pradesh, Uttar Pradesh, Rajasthan, Maharashtra,	2000	internet

			Kerela and Tamil Nadu		
mKRISHI	Tata Consultancy Service (TCS)	TCS	Maharastra	-	Mobile
Nokia Life Tools	Nokia	Nokia	India	2008	Mobile
OSCAR (Open Source Simple Computer for Agriculture in Rural Areas)	IFP (French Institute of Pondicherry	Rice-Wheat Consortium for Indo-Gangetic Plains, India, French Agricultural Research Centre for International Development (CIRAD),	India	2006	Internet
Tata Kisan Kendra	Tata Chemicals Limited (TCL)	Tata Chemicals Limited (TCL)	Farmers of Haryana, Punjab & UP	2003	Internet
NGO-initiatives					
Ashwini (v-Agri v-Aqua)	Byrraju Foundation	NISG- (National Institute for Smart Government)UNDP	AP	2005	Internet
Creating Rural Entrepreneurs through ICT enabled Enterprise Development Services	Development Alternatives (Tarahaat Informational & Marketing Services Ltd.)	UNDP-NISG	UP & MP	2005	Internet
information Village Centers of MSSRF	M S Swaminathan Research Foundation (MSSRF)	International Development Research Centre (IDRC), Canada	12 villages in Pondicherry region	1998	Internet
Jagriti e-Sewa	Jagriti-eSewa	Jagriti	Punjab	2003	Internet
Jamset Ji Tata National Virtual Academy for Rural Prosperity	M S Swaminathan Research Foundation (MSSRF)	Sir Dorabji Tata SchoolWelfare Trust	Pondicherry	2003	Internet

Rural Knowledge Center (RKC)	Microsoft Corporation India Private Limited, NASSCOM (National Association of Software and Services Companies) Foundation and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT	Microsoft (Nasdaq "MSFT")	Nine coastal states of India –West Bengal, Orissa, Andhra Pradesh, Tamilnadu, Kerala, Karnataka, Goa, Maharashtra and Gujarat.	2004	Internet
Swayam Krishi Sangam (SKS) Microfinance	Swayam Krishi Sangam	Women's World Banking, CGAP, Grameen Foundation USA, American India Foundation	Rural poor, landless laborers or marginal farmers, women and Dalits of Andhra Pradesh, Karnataka, Maharashtra, Orissa and Madhya Pradesh	1998	Internet
Warna Wired Villages Project	National Informatics Centre (NIC), Directorate of Information Technology, Government of Maharashtra (GoM) and Warana Sahakari Dudh Utpadan Prakriya Limited (WSDUPL)	National Informatics Centre (NIC) and Farmers and rural population of Warna Nagar Directorate of Information Technology, Government of Maharashtra (GoM	Farmers and rural population of Kolhapur and Sangli district, Warna Nagar, (Maharashtra)	1998	Internet

ICT is helpful in providing accurate, timely, relevant information and advice to the farmers, thereby facilitating favourable platform for more remunerative agriculture. In contest to Indian agriculture, the ICT movement is still evolving. Except few ICTs based projects- Kisan Call Center of DAC which covers entire country, e-soil health card programme that covers state of Gujarat and KISSAN Kerala, most of ICTs project for farming community have been implemented in very limited geographical area and covering few thousand of population. The common problems in adoption of ICT for greater farming community are ICT illiteracy, availability of relevant and localized contents in their own languages, poor electricity supply in rural areas, poor tele-density in rural areas (4.92 against overall 59.63) easy and affordable accessibility and other issues such as awareness and willingness for adoption of new technologies among the rural peoples etc.. For effective information delivery, tradtitional extension methods (personal contact methods, print media, radio and TV) should be supplemented with new ICTs tools involving research institutions, government agencies, NGOs, private sectors in public- private –participatory(PPP) mode.

REFERENCES:

Extract from Karshaka Information Systems Services and Networking website at http://www.kissankerala.net. Extract from National Agricultural Innovation Project (NAIP) website at http://www.ekrishinaip.in

Extract from ITC *e*-Choupal website at http://www.echoupal.com/ Maru, Ajit. *Information and Communications Technology Use in Agricultural Extension in India www.cta.int/en/content/download/2811*

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

Sharma,V.P (2001). Cyber Extension: The Extension Approach for new Millennium,MANAGE,Hyderabad.www.manage.gov.in

Telecom regulatory authority of India (2010). www.trai.gov.in lecture for training course on Information and Communication Technology and Improved Agricultural Practices for Enhancing Productivity under Changing Climate Situation

SIGNIFICANCE OF INFORMATION TECHNOLOGY IN RESOURCE CONSERVATION AGRICULTURE

Dr. A. R. Khan
Principal Scientist, Soil Physics

Conservation Agriculture (CA) provides a comprehensive set of principles to guide efforts to develop improved and sustainable technologies for diverse cropping/farming systems. These underlying principles of CA are not site specific but can be applied to essentially all crop production systems. Conservation agriculture aims to make better use of agricultural resources through the integrated management of available soil, water and biological resources, combined with limited external inputs. It contributes to environmental conservation and to sustainable agricultural production by maintaining a permanent or semi-permanent organic soil cover (FAO 2010). Adoption of CA at the farm level improves resource use through an integrated management approach. It contributes to sustainable production and its advantages include reduction in labour, lower farm-power inputs, more stable yields and improved soil nutrient exchange. Crop production profitability under CA tends to increase over time relative to conventional agriculture. Other benefits attributed to CA at the watershed level relate to more regular surface hydrology and reduced sediment loads in surface water. At the global level, CA sequesters carbon, thereby decreasing CO_2 in the atmosphere and helping to dampen climate change. It also conserves soil and terrestrial biodiversity. Conservation agriculture is practiced on about 57 million ha, or on about 3 percent of the 1 500 million ha of arable land worldwide (FAO, 2010).

Why conservation agriculture (CA)

- Stabilize/reverse widespread soil degradation to enhance sustainability of natural resources of land, water and air
- Enhance water use efficiency for both rained and irrigated crop production systems
- Increase crop productivity through increasing time and input use efficiency
- Reduce production costs for farmers and improve family livelihoods

Advantages of conservation agriculture

- Reduce soil erosion from wind and water
- Improve water use efficiency
- Improve soil physical, chemical and biological properties
- Enhance soil carbon sequestration
- Reduce turn-around-time between crops
- Reduce costs of production

If done properly, CA adoption also can make more efficient use of agricultural inputs, enhance water productivity and help mitigate potential climate change associated with GHG emissions. More importantly, however, it offers farmers new prospects to improve the economic viability of farming operations.

Potential disadvantages of conservation agriculture planting systems

- Reduced soil temperatures during cool periods leading to stand establishment problems
- Weed control may be more problematic
- Disease, insect and rodent incidence may change/increase
- Aesthetics of field difficult for some farmers to accept

Fatigue in natural resource base

The green revolution is one of the most striking success stories of post-independence India. The success was reflected through more efficient dry matter partitioning to reproduction and therefore, higher harvesting index with significant gain in the yield potential. It is the combination of green revolution varieties and their responses to external inputs, which produced meaningful advances in agricultural productivity (Malik, 2010). Rice - Wheat (RW) is the most important crop rotation covering nearly 10 million ha area in India. The area under rice and wheat cultivation in Bihar is 3.8 and 2.2 million ha, respectively. Sustainability and profitability of rice-wheat cropping system in Indian agriculture is the lifeline and future of Indian economy with more than 60 per cent people living in rural areas. Concern has been expressed about the long-term sustainability of the rice-wheat system as there is an indication of yield stagnation or a tendency to decrease with time over parts of the Indo-Gangetic plains (Khan, 2009). It is now appearing that RW systems have fatigued the natural resource base. Continuous cropping of rice-wheat system for several decades as well as contrasting edaphic needs of these two crops have resulted in increased pest pressure, nutrient mining, and decline in yields in some areas**.** The reasons for declining in the productivity growth rate are multiple (Duxbury *e al.*, 2000; Ladha *et al.*, 2000; Timsina and Connors, 2001). The income of farmers is further reduced due to increase in cost of farm inputs (seed, fertilizer, tillage, irrigation and labour, etc). Assessment on the scientific, technical and institutional issues associated with cropping system is needed. The challenges are enormous ranging from conservation of natural resources to investment in new technologies based on biotechnology. The major challenge is to develop such system that produce more with environmental security at minimal economic costs, improve profitability and long-term sustainability.

Resource Conservation Technologies (RCTs):

Resource conserving crop management systems in sustainable crop production have begun to adopt and be adapted improved crop management practices, a step toward conservation agriculture. It focuses on the complete agricultural system, involves major changes in farm cropping operations from the widely used conventional tillage-based farming system. Appropriate Resource conserving technologies (RCTs) encompass an innovative crop production system that combines the dramatic reduction in tillage with an ultimate goal to achieve zero till or controlled till seeding (including strip till and the in-furrow soil disturbance associated with reshaping permanent raised beds) for all crops in a cropping system. It also encourage for rational retention of adequate levels of crop residues on the soil surface to arrest run-off and control erosion; improve water infiltration and reduce evaporation; increase soil organic matter and other biological activity to enhance land and water productivity on sustainable basis (Khan *et al.*, 2009, Sayre, K.D., 1998). Any new technology that is more cost and/or input use effective (produces more for the same or less input) as compared to an existing technology in use is examples of RCTs:

- More efficient implements for reduced/minimum/zero till seeding
- Direct/surface seeding
- Direct sowing of rice in puddled field through drum seeder
- Bed planting of rice & wheat

- Potato + Maize on raised bed
- Varied crop rotation
- More effective fertilizer management practices
- Nitrogen management through brown manuring and leaf colour chart
- More useful weed, disease or pest control practice
- Laser land leveling for increasing land & water productivity
- New cultivars
- Residue management
- Crop intensification & diversification

RCTs validation through farmers' participatory research

The resource conserving technologies were successfully demonstrated in the NATP project at different locations in Indo-Gangetic plains. Farmers' participatory field trials were conducted in Punjab, Haryana, Bihar, U P and West Bengal since 2000, where in rice and wheat crop was established using conventional, zero-till and raised bed methods. ICAR Research Complex for Eastern Region is leading the research on resource conserving technologies in eastern Indo-Gangetic plains (EIGP) and relevant technologies were assessed, tested, refined, demonstrated, validated and up scaled in EIGP at farmers' field in participatory mode (Khan, 2010). These coordinated activities include: community awareness programs; farmer, researcher and extension agent training; on-farm participatory demonstration plots; on-farm and on-station strategic research combined with well-developed adaptive research, support for farmer-to-farmer exchange and study tours. Regular monitoring and evaluation of advances and farmer perceptions, and the adjustments to respond to these, help ensure a dynamic and successful development process. This has been well demonstrated by the initial use of fields of innovative farmers by the Rice-Wheat Consortium to extend CA-based zero till seeding practices to farmers in South Asia. Adoption in over 2 ha million in occurred exponentially over a period of ten years (Malik, 2010). The findings influenced the policies of State Governments for extending subsidies on RCTs machines and led to the emergence of machinery service providers for RCTs adoption and sustainability. National Agricultural Research System (NARS) is at the forefront of this work and because it is done with farmers in their fields, adoption is accelerated. Indian Council of Agricultural Research (ICAR), Rice Wheat Consortium, CIMMYT and IRRI encouraged the State Agricultural Universities, State Governments, NGOs, the private sector and extension agencies to test and adapt these approaches and feature them in rural development strategies.

Toward sustainable management of cropping systems through RCTs

Farmers in the Indo-Gangetic Plains have now rediscovered the virtue of technologies like zero-tillage and bed planting because they are profitable and add value to the system as a whole.

(a) Direct seeded rice (DSR): Direct seeded rice under zero-tillage, puddled and unpuddled situations could be other options for raising this crop and avoiding tedious practice of transplanting. The transplanting of rice under un-puddled conditions or direct sowing under zero-tillage can be an alternative for improving water productivity in the medium soils. Drum seeder are used to sow the pre-germinated seeds in thoroughly puddled land. One person with steady speed walk can easily sow around 1.5 acres.

(b) Nitrogen management through brown manuring and leaf colour chart (LCC): *Sesbania* is used as green manure in direct seeded / transplanted /Zero Tillage (ZT) rice. Brown manuring practice was introduced where both rice and *Sesbania* crops @ 20 kg/ha were seeded together and allowed to grow for 30 days. Subsequently co-cultured *Sesbania* crop was dried by spraying

2, 4-D ethyle easter @ 800 g a.i./ha dissolved in 800-liter water. The dried leaves of *Sesbania* fallen on the soil gets decomposed very fast to supply N, organic carbon and other recycled nutrients to the crop. Weed population was also reduced by nearly half without any adverse effect on rice yield. Farmers also found that there were fewer incidences of pests due to the brown manuring. Excess N use (110 – 150 kg/ha) through urea is a common practice in rice – wheat system against recommended dose of 80 – 100 kg/ha. LCC helped farmers to measure the leaf colour intensity, which is directly related to leaf chlorophyll content and leaf nitrogen status. The timings of nitrogen top dressing can be easily determined based on soil N supply and crop demand. This simple tool helped farmers to reduce the excess use of nitrogen fertilizers. The use of LCC and brown manuring through *Sesbania* could save the nitrogen use through chemical fertilizer in rice crop, which ultimately saved the resource of the farmers and there was increase in yield also. There was saving of 42 kg N/ha due to LCC and 36 kg N/ha due to *Sesbania* co-culture (Khan, 2009).

(c) Water saving & financial gains due zero tilled direct seeded rice: There was saving of nearly 35% of irrigation water in zero till direct seeded against puddled transplanted rice in Patna during critical dry spell (Khan *et al*., 2006). Zero tilled direct seeding of rice in early monsoon phase saved rain/canal water in puddling (100 to 130 mm) and need of excess water for irrigation in case of dry spell and cracking of heavy soils. The bed planting of rice can also be used for improvement in the water productivity. There is a net saving of Rs. 6,800/ha in crop establishment due to zero till direct seeded rice (ZTDSR) as against the conventional puddled transplanted (PT).

(d) Zero tilled wheat: Zero-tillage has enabled farmers to sow their wheat crop immediately after rice harvesting and without any pre-sowing irrigation in most cases. The water saving under zero-tillage has been recorded at the time of first post-sowing irrigation (Gupta and Gill, 2003; Malik *et al*., 2004). Direct dry sowing using zero-till seed drill, and use of permanent Furrow Irrigated Raised Beds (FIRBs) for planting wheat can reduce the cost and saves time in land preparation. It also saves irrigation water for the crop growth. Similarly, the bed planting of wheat can be used for a significant improvement in the water productivity. It was observed that sowing of wheat in conventional tillage is generally done at 60 to 65 per cent of field capacity of soil, whereas sowing can be done at 85-90% of field capacity in zero tillage. This facilitates 10 to 12 per cent more utilization of residual soil moisture. The normal time taken to irrigate one-hectare field of conventional tilled wheat field is 20 to 21 hours with 5 HP pump whereas it took only 14 to 15 hours in zero tillage. Thus there is a net saving of 5 hours of pumping, which reduces the use of energy and irrigation cost for zero tilled wheat crop.

(e) Double Zero tillage: Wheat was sown in the same field without ploughing after the harvest of zero till direct seeded rice (ZTDSR). Wheat crop is also sown in the presence of the residue of rice crop harvested in the month of November. The residue of rice was around 4.0 – 4.5 t/ha in manually harvested fields, added biomass in the soil and improve the soil properties (Khan and Singh, 2008). The incorporation of silica rich rice residue has been found to enhance the water availability to wheat crop and to increase the groundwater recharge (Nanda *et al*., 2000).

(f) Laser aided land leveling: Laser land leveling is an important component of resource conservation technology that can improve water productivity at field level (Gupta *et al*., 2003). There is an increase of 3-5 per cent cultivable area due to reduction in bunds and channels in the field. It further improves the crop uniformity, crop stand, water productivity and yields. Time of field operation is also reduced.

(g) Residue management: Large quantity of residue is left in the field due to mechanized harvesting and farmers have been compelled for burning or removing the straw left in the field. Managing heavy crop stubbles (7-10 t/ha) is a major problem. Burning of stubbles is a rapid and cheap option. Residue burning causes air pollution (particulates and green house gases emission), nutrient loss (especially nitrogen, carbon, phosphorus, potassium and sulphur) and soil organic matter decline. There are serious threat to soil, human & animal health, biodiversity and environment (Ghatala and Saharawat, 2009). Now in India, many RCTs machines like Turbo/Happy seeder and rotary drill disk etc are available for planting rice, wheat and other crops directly in presence of residue. The ability of the Turbo seeder is direct drilling of seed and fertilizer into a combine harvested field (without straw removal/burning) in a single operation by managing only that part of straw which is coming just in front of furrow openers. Nutrient supply can be achieved from the residues left in the field provided it is incorporated and recycled. About 25% of nitrogen (N) and phosphorus (P), 50% of sulfur (S), and 75% of potassium (K) uptake by cereal crops are retained in crop residues, making them valuable nutrient sources (Singh and Singh, 2001).

Role of ITC in Resource Conservation Agriculture

Communication has been used throughout human history to impart information, teach skills, influence attitudes and perceptions, moderate debate and disagreement, create connections between individuals and groups, inspire new ideas, and facilitate. At the core of the conservation movement has been a communication movement. Earlier it was from farmers to farmers through their experience and exchange of views. This is primarily because conservation agriculture requires change, and change requires communication, cultural and behavioral changes for adoption of a new technology. Cell phones, computers and the Internet have revolutionized communications. One can now talk to almost anyone at anytime from anywhere in the world. These information technologies have also accelerated economic globalization and the spread of technologies. Applications such as Google Earth enable anyone with an Internet connection to virtually explore any place on the planet using interactive maps and high-resolution satellite images. ICT (information and communications technologies) consists of all technical means used to handle information and aid communication, including both the computer and network hardware as well as necessary software. In other words, ICT consists of IT as well as telephony, broadcast media, and all types of audio and video processing and transmission. Nowadays, the use of ICT in agriculture is gaining higher importance. Effective communication is multi-directional (Rogers 2003). Communication is more likely to be effective—lead to increased knowledge, changed behavior, etc.—if people have an opportunity to ask questions, discuss with others, actively process content, and apply information in a social context (Brown and Adler 2008). When people feel like they are a part of the communication experience rather than just recipients of an informational product, they are more likely to be engaged with the material and use it (FAO 2006). The policy makers have embarked on initiatives like introduction of alternate cropping systems to conserve natural resources. Some of the significant advantages of ICT are timely information on weather forecasts and calamities, better and spontaneous agricultural practices. E-Agriculture is an emerging field focusing on the enhancement of agricultural and rural development through improved information and communication processes. More specifically, e-Agriculture involves the conceptualization, design, development, evaluation and application of innovative ways to use information and communication technologies (ICT) in the rural domain, with a primary focus on agriculture (Bharati *et al.*, 2010).

Conclusion

Conservation Agriculture (CA) aims to conserve, improve and make more efficient use of natural resources through integrated management of available soil, water and biological resources combined with external inputs. It contributes to environmental conservation as well as to enhanced and sustained agricultural production. It can also be referred to as resource-efficient / resource effective agriculture. Farmers in both developed and developing countries are confronting new challenges related to the globalised economy, accelerating production costs and now climate change. Conventional farming practices that involve tillage for land preparation and weed control, removal or burning of crop residues and mono-cropping are associated with soil erosion and degradation of the soil health needed for efficient water productivity and sustainable crop production. In Indo-Gangetic plains efforts are made since 2000 for new approach to farm management to address the issues of zero/reduced tillage, retention of crop residues, laser levelling and the use of more intensified and diversified crop rotations. ICT is used as a most powerful weapon to reach the farming community to adopt the new technologies of resource conservation agriculture to enhance the land and water productivity with environmental security, improved profitability and long term sustainability.

References

Bharati, R.C., Kumar, A., Kumar, U. and Chandra, N. (2010). Role of information technology in agriculture. *In Khan, A.R., Singh, S.S., Bharati, R.C., Srivastava, T.K. and Khan, M.A (edited). Resource conservatorium technologies for food security and rural livelihood.* RWC-IRRI India, New Delhi. pp. 485-493.

Brown, John Seely, & Adler, Richard P. (2008, January/February). Minds on fire: Open education, the long tail, and learning 2.0. EDUCAUSE Review, 43(1), 16-32.

Duxbury, J.M., I.P., Abrol, R., Gupta, and Bronson, K., (2000). Analysis of soil fertility experiments with rice-wheat rotations in S. Asia. RWC Paper Series 5. Rice-Wheat Consortium for the Indo-Gangetic Plains and CIMMYT, New Delhi, India.

FAO. (2006). Agriculture and Consumer Protection Department. Rome, Italy

FAO. (2010). Document Repository: Natural Management and Environment IV. Rome, Italy

Gathala & Saharawat (2009). Happy seeder technology: an alternate option for managing loose straw after combine harvest. *National Level Winter School training (ICAR) Course on Resource Conservation Technologies –Conserving resources for enhancing productivity, sustainability, food security and improvement of rural livelihoods*. ICAR-RCER, Patna. Nov. 5-25, 2009.

Gupta, R. K. and Gill, M. A. (2003). New Opportunities for Saving on Water: Role of Resource Conservation Technologies. Addressing Resource Conservation Issues for the Indo-Gangetic Plains. RWC- CIMMYT India, New Delhi. pp. 199-204.

Gupta, R. K., Listman, G. M. and Harrington, L. (2003). The Rice – Wheat Consortium for the Indo - Gangetic Plains: Vision and Management Structure. Addressing Resource Conservation Issues for the Indo-Gangetic Plains. RWC- CIMMYT India, New Delhi. pp. 1-7.

Khan, A. R. (2009). On-farm farmers' participatory trials in Eastern Indo-Gangetic plains. 15th Regional Technical Coordination Committee (RTCC) meeting, RWC-IRRI, New Delhi 2-3 Feb 2009

Khan, A. R. (2010). Resource conservation technologies for food security and rural livelihood in eastern Indo-Gangetic plains. *In Khan, A.R., Singh, S.S., Bharati, R.C., Srivastava, T.K.*

and Khan, M.A (edited). Resource conservatorium technologies for food security and rural livelihood. RWC-IRRI India, New Delhi. pp. 25-60.

Khan, A.R., Sikka, A.K., Singh, S.S. and Gupta, Raj K. (2006). Resource Conservation Technology through Zero Tillage in Eastern India. 18th World Congress of Soil Science, Pennsylvania, USA. July 9-15, 2006. Khan, A. R. and Singh, S S. (2008). Zero tillage technology for wheat sowing. Rice-Wheat Consortium Extension Folder. RWC /IRRI, New Delhi, pp.12.

Khan A. R and Singh S S. (2008). Zero tillage technology for wheat sowing. Rice-Wheat Consortium Extension Folder. RWC /IRRI, New Delhi, pp.12.

Khan, A. R., Singh, S. S., Khan, M. A (2009) Emerging Resource Conservation Technologies in Eastern Indo-Gangetic Plains of India. International Conference on Food Security and Environmental Sustainability (FSES 2OO9). *Lead Paper*. I.I.T., Kharagpur, December 17-19, 2009.

Khan, A. R., Singh, S. S., Khan, M. A. Erenstein, O., Singh , R. G. and Gupta, Raj K. (2009). Changing Scenario of Crop Production through Resource Conservation Technologies in Eastern Indo Gangetic Plains. World Congress on Conservation Agriculture (WCCA), New Delhi, February 4 to 7, 2009.

Ladha, J.K., Fischer, K.S., Hossain, M., Hobbs, P.R. and Hardy, B., (2000). Progress towards improving the productivity and sustainability of rice-what system: a contribution by the consortium members. IRRI Discussion Paper No. 40.

Malik, R.K. (2010). Resource conservation technologies in rice-wheat cropping system of Indo-Gangetic plains. *In Khan, A.R., Singh, S.S., Bharati, R.C., Srivastava, T.K. and Khan, M.A (edited). Resource conservatorium technologies for food security and rural livelihood.* RWC-IRRI India, New Delhi. pp. 78-91.

Malik, R.K., Yadav, Ashok, Gurjeet S., Gill, Parveen, Sardana, Gupta, R. K. and Colin Piggin, (2004). Evolution and acceleration of no-till farming in rice-wheat system of the Indo-Gangetic Plains. 4th International Crop Science Congress held in Brisbane, Australia from September 26 to October 1. P. 73.

Nanda, P., Khan, A. R., Ghorai, A. K. and Chandra, D. (2000). On farm evaluation of straw ulch on pointed gourd production. Indian Farming. 50 (7): 37 – 39.

Rogers, E. M. (2003). Diffusion of innovations. New York: Free Press.

Sayre, K.D., (1998). Ensuring the use of sustainable crop management strategies by small wheat farmers in the 21st century, Wheat Special Report No. 48. Mexico, D.F. CIMMYT

Singh, Y. and B. Singh. (2001). Efficient Management of Primary Nutrition in the Rice-Wheat System, pages 23-85. *In:* Kataki, P.K. (ed). The Rice-Wheat Cropping Systems of South Asia: Efficient Production Management. Food Products Press, New York, USA.

Timsina, J. and Connor, D.J. (2001). The productivity and sustainability of rice-wheat cropping systems: Issues and challenges. *Field Crops Res. J*. 69 (2001) 93-132.

Role of ICTs in Animal Disease Management

Pradeep Kumar Ray
Division of Livestock and Fisheries Management

Information and Communication Technology is a revolutionary tool in recent decades which has impact on almost all fields of life. It is a well known fact that ICT is very useful and efficient in Livestock Management, Veterinary hospitals management and Animal Diseases monitoring and Surveillance throughout the world. Information is power but the desired goal can be attained only when there is systematic dissemination or transfer of information. Unlike plant diseases which are mostly affecting majority of the population at once, animal diseases can be of individual or herd problem. Widely animal diseases are categorized into two viz. Infectious and Non-infectious. Most of the infectious diseases are contagious and tend to spread to other animals even to human beings. Non-infectious diseases are mostly limited to individuals and exception is Nutrient deficiency syndromes.

INFORMATION

Information is the knowledge acquired through study, experience and instruction. Communication technology is the modality of disseminating the information to the targeted population. Any communication technology can survive better when it has more reach, readability, reliability, rapidity and readiness to be used. As far as the livestock health is concerned, information has to be transpired between farmers, technical stakeholders and government. Looking at the scenario *in toto*, information about the outbreaks, causative agent, epicenter of outbreak, population at risk, Case fatality rate, morbidity and environmental determinants are essential to make a centralized decision with regard to herd health and public health.

ICT TOOLS

The use of ICT in animal husbandry and hospital management dates back to the period of arrival of computers. Since then various ICT tools are used at different levels. Conventional communication modalities like print media, radio broadcastings, television, CD-ROMs, Handheld computers have been very widely used. Recent concepts like Internet, Geographical Information System (GIS), Global Positioning System (GPS), Database Management, Computer Aided Design (CAD), computer Networking, Artificial Intelligence adds strength and efficiency to the ICT in animal disease management. Most of the ICT tools currently used are in Herd Health management.

Telemedicine

Telemedicine is in absentia animal health service given to needy. This may be as simple as telephonic consultation to intra-operative consultation through video conferencing. Telemedicine is broadly classified as Synchronous or Real-time telemedicine and Asynchronous or Store-and-forward telemedicine. Synchronous telemedicine requires real time video conferencing facility so that the expert looks at the happenings and guides the attending clinician. Information revealed by various diagnostic tools can be communicated and intervention can be sought on real-time basis. Asynchronous telemedicine requires image storage and transfer facility so that the stored image can be forwarded to the expert and intervention can be sought. Some disadvantages of Telemedicine are (1) the expert does not have opportunity to do physical examination of the patient. He / she has to rely only upon inputs from attending veterinarian or laboratory data (2) there is possibility for miscommunication and distortion of information in Telemedicine.

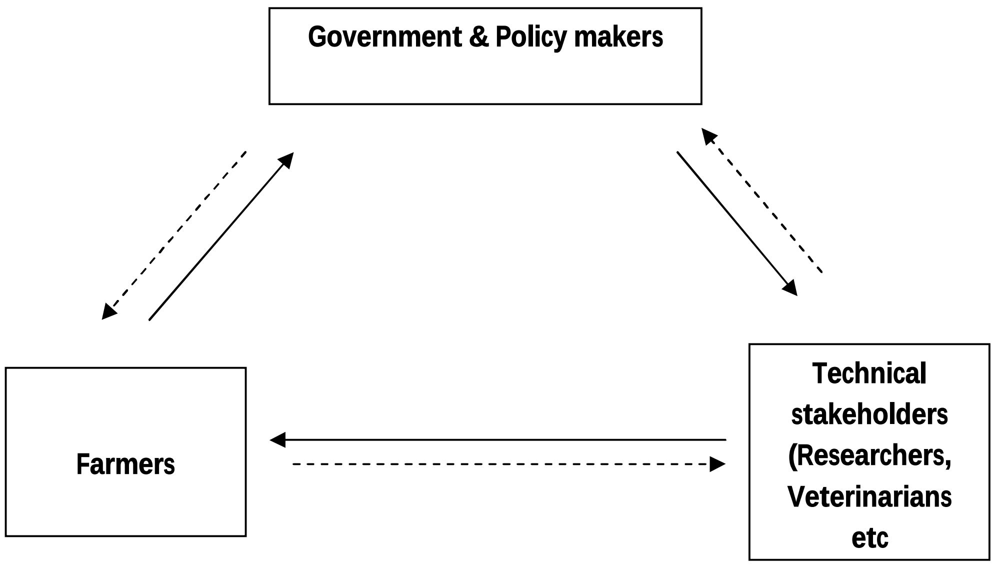


Fig: 1. The flow of information between various stakeholders

Internet

Internet becomes the lifeline of most of the ICT tools as communication between information pools is done through internet only. Besides that, education and updating of technical stakeholders happens through vast information and literatures uploaded in various web portals. Currency of information is essential for ever changing scientific developments. Online libraries, downloadable textbooks, catalogues, encyclopedias, magazines, newsletters, refereed journals, presentations, databases, images, videos are available to the researchers and other technical stakeholders of Animal Diseases management at negligible cost. With all these advantages, internet also have some deficits like lack of authenticity, under -validated information, lack of reliability, contradictory information from different sources and informations with ulterior motives. Recognizing the due importance of accessibility of scientific literature by NARS personnel and networking of various institutes of ICAR and SAU's, the NAIP has established the Consortium for e-Resources in Agriculture (CeRA) at the Indian Agricultural Research Institute (IARI), New Delhi.

Geo-informatics technologies

At present, Geographic Information System (GIS), Remote Sensing (RS) and Global Positioning System (GPS) are used in convergence for animal disease management. Both GPS and GIS collect and analyze the data with geographical reference respectively. These geo-reference points are based on the longitude and latitude coordinates of the location under study. The use of GIS and RS is now generally applied by the scientific community for animal diseases monitoring and surveillance, epidemiology, parasitology..etc. Geographical Information System (GIS) and RS have been very successfully used in studying the Tsetse fly population transmitting Trypanosomosis, Snail intermediate host for liver fluke and Tick-borne East Coast fever. The GIS was used in veterinary epidemiology in 1970s. GIS was used retrospectively by Canadian Scientists to study the pattern of spread of the 1967-1968 Foot and Mouth Disease (FMD) outbreak in England. It was used to understand the diseases' incubation period and its spread from herd to herd. Remote sensing (RS) is satellite imaging of geographical locations and interpreting based on the differences in the intensity of energy emission or reflection. Aerial imaging uses the solar radiation as the source energy for studying the reflection passively. Light Detection and Ranging (LIDAR) is a mode of remote sensing very commonly used for monitoring deforestation. It can also be used for studying contamination of rivers by industrial effluents and mineral mapping of soil. As LIDAR is commonly applied for vegetation studies, it will be of use in identifying the indicator plants growing in specific nutrient excess. For example, Selenium indicator plants like *Astragalus spp.* and *Crotalaria spp.* can be located and indirectly the soils with toxic levels of selenium can be identified. Movement of foxes and Rabies in wild environment and their interaction with domestic animals was also studied using GIS and RS.

Database Management & Computer Networking

There are number of Veterinary Hospital Management Softwares available in the market. They are intended to arrange, store, recall, analyze and transfer the data through networking. Computer Networking is the practice of linking computing devices together with hardware and software that supports data communications across these devices.

Computer-aided design (**CAD**)

Also known as **computer-aided design and drafting** (**CADD**), is the use of computer technology for the process of design and design-documentation. Computer Aided Drafting describes the process of drafting with a computer. CAD software, or environments, provides the user with input-tools for the purpose of streamlining design processes, drafting, documentation, and manufacturing processes. CAD output is often in the form of electronic files for print or machining operations. With the introduction of Computer-assisted drug development (CADD) in pharmaceutical industry for drug development based on the integration of mathematical modeling and simulation, the cost of synthesizing and validating a new molecule becomes cheaper as the CADD reduces almost 50% of the cost. This methodology provides a knowledge-based decisional tool on alternative development strategies based on the evaluation of potential risks on drug safety, and the definition of experimental design of new trials with expected power and probability of success **The medical modeling**: It has been used mainly for research application. For veterinary practice it is still in infancy and case studies include designing of prosthesis for pet animals. But like any other machine modeling CAD is being used widely for the designing of instruments meant for veterinary application. Medical modeling describes steps in the process from acquisition of medical scan data, transfer and translation of data formats, methods of utilizing the data and finally using the information to produce physical models using rapid prototyping techniques for use in surgery . Some of the examples of ICT tools being used are given below.

TADinfo

Recognizing the need for an animal health data retrieval system to store records for epidemiological analysis, in 1993 the FAO initiated the Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases (EMPRES). One of the priorities of EMPRES was to develop a veterinary data and disease incidence recording system for national veterinary services, equipped with GIS mapping capability to facilitate early warning and responses to outbreaks of Transboundary Animal Diseases (TAD). In 1999 EMPRES issued the first version of TADinfo, a software package consisting of a Microsoft Access database linked to an Arc View mapping function, with Tanzania as the first user country.

Pacific Animal Health Information System (PAHIS)

Pacific Animal Health Information System (PAHIS), a database and decision support system issued on CD-ROM for veterinary officers in pacific region. Regional Animal Health Service (RAHS) in collaboration with the Office International des Epizooties (OIE), has developed the Pacific Animal Health Information System (PAHIS) database, which is now available on CD-ROM. The PAHIS CD-ROM contains a wide range of information, including country reports, contact details, livestock populations by country and by species, and the veterinary facilities and infrastructures in Pacific countries. It also contains updated information on the distribution of animal diseases, based on data from the OIE's World Animal Health yearbook, and from disease surveys and animal health status reports. Similarly, East African Integrated Diseases Surveillance Network (EAIDSNet) is one such successful example.

World Animal Health Information Database (WAHID)

Animal disease data available with Office Internationale Epizooties (OIE) are accessible through WAHID. Information on recent outbreaks and outcomes of the outbreaks was compiled by pooling the information provided by the member countries. And six monthly reports of the OIE listed disease status in member countries are also available.

aAQUA (almost All Questions Answered)

aAQUA is a multilingual, multimedia question answer system for delivering information to grassroots Indian community developed by Media Labs Asia, IIT Bombay. This project functions through information kiosks manned with computer operators. These operators act as receivers of information and the questions are passed on to the Experts located far away. This has the potential of being used as Asynchronous & / or Synchronous telemedicine venture if provided with image transfer facility.

<u>EMPRES</u> (Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases)

The goal of the Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases (EMPRES) is to promote the effective containment and control of the most epidemic livestock diseases through epidemiological surveillance, contingency planning, early warning systems and global coordination.

Bibiliography

Alexandre Fediaevsky. 2003 PAHIS: Pacific animal health information. Issue 15: Livestock. Available online at http://ictupdate.cta.int

Hendrickx, G., Biesemans J. and De Deken R. (2004). The use of GIS in Veterinary Parasitology. *In: GIS and Spatial Analysis in Veterinary Science, Durr, P.A and Gatrell A.C. Editors.* CABI Publishing, Wallingford, UK, 145-176.

Juan Lubroth and Akiko Kamata. 2005. TADinfo: An information system for animal health: 24: Invasive Species: available online at http://www.tadinfo.org

Shrikant Kulkarni, A.M. Kotresh and Santosh Sarangamath. 2009. Application of Information Technology. *In: Animal Health in Information Technology in Veterinary Science.* New India Publishing Agency, New Delhi.

Taft CA, Da Silva VB and Da Silva CH. 2008. Current topics in computer-aided drug design. *J. Pharm. Sci*. 97(3):1089-98

Vivek Dhawan.2004. Critical success factors for rural ICT projects in India: A study of n-Logue kiosk projects at Pabal and Baramati. Master of Management Thesis submitted to Indian Institute of Technology, Bombay

Vivek M. Patil. 2009. Information Technology and Its Applications. *In: Information Technology in Veterinary Science*, New India Publishing Agency, New Delhi.

Vivek R. Kasaralikar. Telemedicine in Veterinary Practice. *In: Animal Health in Information Technology in Veterinary Science.* New India Publishing Agency, New Delhi.

Women empowerment through ICTs

Dr. Shivani
Senior Scientist, Agronomy

According to the World Bank [2004] the main key services fail poor people – in access, quantity and quality. This necessitates a set of development targets known as Millennium Development Goals [MDG]. These call for halving of the global poverty and broad improvements in human development by 2015. One resource that liberates people from poverty and empowers them is knowledge. The Millennium Declaration adopted by UN in 2000 underscored the urgency of ensuring that the benefits of new technologies, especially Information and Communication Technologies [ICTs] are made available to all.

Information and Communication technologies (ICTs): what does it mean?

ICT (information and communications technology) is an umbrella term that includes any communication device or application, encompassing: radio, television, cellular phones, computer and network hardware and software, satellite systems and so on, as well as the various services and applications associated with them, such as videoconferencing and distance learning. It is the study of the technology used to handle information and aid communication. The phrase was coined by Stevenson in his 1997 report to the UK government and promoted by the new National Curriculum documents for the UK in 2000. Information and Communication Technologies [ICTs] are a diverse set of technological tools and resources to create, disseminate, store, bring value addition and manage information. ICT comprise a complex and heterogeneous set of goods, applications and services used to produce, process, distribute and transform information. Traditional technologies continue to be important for large numbers of people around the world, particularly in rural areas. However, new technologies have a vast potential for empowerment, which needs to be fully exploited. Over the past decade, there has been a growing understanding that these technologies can be powerful instruments for advancing economic and social development through the creation of new types of economic activity, employment opportunities, improvements in health-care delivery and other services, and the enhancement of networking, participation and advocacy within the society. ICT also have the potential to improve interaction between Governments and citizens, fostering transparency and accountability in governance. While the potential of ICT for stimulating economic growth, socioeconomic development and effective governance is well recognized, the benefits of ICT have been unevenly distributed within and between countries. The term “digital divide” refers to the differences in resources and capabilities to access and effectively utilize ICT for development that exist within and between countries, regions, sectors and socio-economic groups. The digital divide is often characterized by low levels of access to technologies. **Poverty**, **illiteracy**, **lack of computer literacy** and **language barriers** are among the factors impeding access to ICT infrastructure, especially in developing countries. Another hindrance pertains to ICT is lack of its **access to women**. Information and communication technologies play a growing role in the world's societies, and have the potential to help disadvantaged groups, increase their participation in the civic, social, political, and economic processes critical to achieving change. However, women – particularly women in developing countries – don’t benefit from these new technologies, a reflection of the existing unequal power relations in societies as a whole. ICTs can be used to either exacerbate or transform unequal power relations. ICTs cannot create gender equality, or end poverty, but they can be tools for social action and positive social change.

Growth of ICT

It is now well understood that any attempt to improve the quality of life of people in developing countries would be incomplete without progress towards the empowerment of women. ICTs are emerging as a powerful tool for gender empowerment in a developing country like India. There has been a rapid growth in the ICT sector since the late 1980s and the use of ICT has dramatically expanded since the 1990s. According to the World Bank, teledensity in India had reached 3.8% of the population by 2001. The number of internet accounts is growing at a rate of 50% per annum. The ITES-BPO sector alone grew at 59%, and employment had reached 106,000 by 2004 [NASSCOM 2004]. The IT and ITES sector is projected to grow 18% in the next five years to become an industry of Rs 4.58 lakh crores by 2011, according to an IDC release. But there is a strong digital divide in society. According to the 2004 report by the Cisco Learning Institute women comprise only 23% of India's internet users. This gender digital divide in India is characterized by low levels of access to technologies.

Indian Perspective

For centuries, women in this country have been socially and economically handicapped. They have been deprived of equal participation in the socio-economic activities of the nation. The Constitution of any country is supreme law of the land and is followed absolutely, subject to the limits provided in the solemn document itself. Thus, for conferring the strongest protection and to emancipate women, the provisions of the Constitution should be interpreted liberally and in a purposive manner. The Constitution of India recognizes women as a class by itself and permits enactment of laws and reservations favouring them. Several articles in our Constitution make express provision for affirmative action in favour of women. It prohibits all types of discrimination against women and lays a carpet for securing equal opportunity to women in all walks of life, including education, employment and participation. The Constitution of India recognizes equality of the sexes and in fact provides for certain provisions under the Chapter on Fundamental Rights more favourable to women but in actual practice they are observed more in breach than in compliance. In our society the freedom of women to seek employment outside the family is a major issue. This freedom is denied in many cultures and this attitude in itself is a serious violation of women's liberty and gender equality. The absence of this freedom militates against the economic empowerment of women, with many other deleterious consequences. Thus, these Constitutional ideal have by and large remained unaccomplished and we have to cover a long distance before the benefits of ICT can be reaped by women effectively.

One of the ignored ICT issues in India is the "gender sensitization" that must be adopted while formulating and implementing the ICT policies in India. It is commonly understood that men and women understand and use computers and Internet differently. Thus, the policy decisions must make sufficient provision for adopting itself with this aspect. Within India also we must understand that the training, use and adoption of ICT must be "gender neutral". For a gender-neutral technology we have to first place the women on an equal platform. They cannot be put on an equal platform till they have equal capacity and opportunity to use ICT. They cannot also effectively use ICT till their "feedbacks and concerns" are incorporated in the National Policies including the E-governance plans. The position is worst when it comes to women, that also rural woman. In our society, whether they belong to the majority or the minority group, what is apparent is that there exists a great disparity in the matter of economic resourcefulness between a man and a woman. Our society is male dominated both economically and socially and women are assigned, invariably, a dependant role, irrespective of the class of society to which she belongs. It must be appreciated that a nation that does not respect its women cannot be described as a civilized nation at all. Such a nation cannot grow and develop and will ultimately perish due to its own rudimentary and tyrannical dogma. Thus, the national consensus should concentrate on betterment of women by suitably empowering them. The plight of the women, however, cannot be improved till they are duly represented in the "power structure" of the nation. In a democratic country the voice of women can be heard only to the extent they are sharing the power structure in the supreme governance of the country. Thus, ICT can play a major role in women empowerment if they are provided employment opportunities at the village level after providing them suitable training. We have to open more village kiosks so that greater women participation can be there.

Knowledge Networking and Empowerment

Empowerment of women in the context of knowledge societies entails building up the abilities and skills of women to gain insight into the issues affecting them and also building up their capacity to voice their concerns. It entails developing the capacities of women to overcome social and institutional barriers and strengthening their participation in the economic and political processes so as to produce an overall improvement in their quality of life. Knowledge networking catalyses the process of women’s empowerment by opening up avenues for women to freely articulate and share their experiences, concerns and knowledge, creating the possibility of their further enrichment. By the use of ICT women can broaden the scope of their activities and address issues previously beyond their capacity. There is a growing body of evidence on the use of ICT to empower women all over the world.

Access to information

Access is the central issue necessary for women’s empowerment. Women have traditionally been excluded from the external information sphere, both deliberately and because of factors working to their disadvantage such as lack of freedom of movement or low levels of education. ICT opens up a direct window for women to the outside world. Information flows to them without any distortion or censoring. This leads to broadening of perspectives, greater understanding of their current situation and the causes of poverty and the initiation of interactive processes for information exchange. Access to ICTs is crucial if they are to be a means for women’s economic empowerment. We need to work towards universal access. It is important not only to establish physical facilities, such as communication networks or computers, but to ensure that these facilities are utilized by their users to the greatest possible extent. Women’s access to and use of ICT is constrained not only by technological infrastructure, but also by socially constructed gender roles and relations. According to a UNESCO report on “Gender Issues in the Information Society”, the capability of women to effectively use information obtained through ICT is clearly dependent on many social factors, including literacy and education, geographic location, mobility and social class. ICT can deliver potentially useful information, such as market prices for women in small and micro-enterprises. For example, use of cellular telephones illustrates how technology can be used to benefit women’s lives, by saving traveling time between the market and suppliers, by allowing women to call for product prices and by facilitating the constant juggling of paid and unpaid family activities. However, use of ICT will be limited in impact wherever women have limited or no access to roads or transport, credit and other development inputs.

Empowerment through Employment

ICT has played an important role in changing the concept of work and workplace. New areas of employment such as teleworking, i.e. working from a distance, are becoming feasible with new technology. The question needs to be asked whether women are getting more opportunities. Undoubtedly, internationally outsourced jobs such as medical transcription and software services have opened up tremendous work opportunities for women in developing countries like India, China and the Philippines. With an expected 500 per cent increase in India's ICT services and back-office work, involving jobs for four million people and accounting for seven percent of GDP by 2008, women's employment in this sector is expected to grow. ICT offers women flexibility in time and space and can be of particular value to women who face social isolation in developing countries. As a result of the technologies, a high proportion of jobs outsourced by big firms are going to women. They can, therefore, work from outside the office – often from their own homes and at any time, thereby raising their incomes to become more financially independent and empowered.

Empowerment through Entrepreneurship

Gothoskar [2000], in an interview with women teleworkers in Mumbai, got responses ranging from welcoming the freedom to fulfill family commitments to dislike of the lack of access to public and social spaces and reinforcement of the role at home. Telecenters can solve these problems by combining homework with social spaces and organization. One way to do this is to move to Entrepreneurship on the internet. The Internet can offer great assistance to Entrepreneurship by women. It offers databases, put together by women's groups, from which women can find relevant links, connections, resources and information and develop partnerships, not just for their services, but also for financing, mentoring and business coaching. It can even mitigate the effect of lack of access to capital. One of the most powerful applications of ICT in the domain of knowledge networking is electronic commerce [E-commerce]. E-commerce refers not just to selling of products and services online but to the promotion of a new class of ICT-savvy women entrepreneurs in both rural and urban areas. E-commerce initiatives can link producers and traders directly to markets at national, regional and even global levels, allowing them to restructure their economic activities and bypass middlemen and the male-dominated and exploitative market structure. Significantly a number of non-profit organizations have diversified their services to provide support to this class of entrepreneurial women. PEOPLink is one such organization, which has been helping women communities traditionally involved with handicrafts to put their products online in the world market. In Gujarat, women producers use the Dairy Information System Kiosk [DISK], which manages a database of all milk cattle and provides information about veterinary services and other practical information about the dairy sector.

Challenges of ICT use for Women's economic empowerment

Women face enormous challenges to use ICT for their own economic empowerment. Using and benefiting from ICT requires education, training, affordable access to the technology, information relevant to the user and a great amount of support [to create an enabling environment]. Access to affordable services and availability of infrastructure is without doubt a major requirement if ICTs are to be used for women's economic empowerment. Availability of electricity, transport and security may also influence the use of ICT. Radio and television, as the widest form of communication, provide one way of solving information dissemination. In addition to being used as effective ICT for development, radio and television should be considered and used as a means of educating the population on the benefits of ICT for development. Radio and Television programmes can be developed to educate women on various development issues, including the various uses of ICT, thus increasing awareness and knowledge of ICT's uses. When possible, such programmes should be developed and conducted by women and their content should reflect a gender perspective. Multimedia can be developed to provide information both in spoken and written language. The challenge is to develop content that is relevant and useful to communities in their own language.

Practical Strategies for Women's Economic Empowerment through ICT use

Understanding the challenges allows us to address the problems better and devise strategies that consider the complex dimension of women's lives. One of the strategies adopted to increase access of remote areas and marginalized groups to ICT is the development of public access centers, such as public phones, telecenters, libraries, information centers or cybercafes. Telecenters can be part of existing institutions such as health centers, schools and community centers. The growth of cybercafes and kiosks has been rapid in India, especially in the southern states where literacy is high. A survey in eight Indian cities has showed that non-working women access the net 63% from cybercafes and 32% from home. A knowledge center project of the M. S. Swaminathan Research Foundation in India has connected four villages in Pondicherry with practical local information in Tamil. This has proved useful in improving agricultural practices and marketing and access to medical facilities. To ensure that women take full advantage of these it is important to make the venue comfortable and safe. In many cases, the location of and arrangements around public access centers are decided without keeping the constraints on women in mind, such as inappropriate opening times [including evenings], security issues and lack of transport. Women's multiple roles and responsibilities may also limit the time available to use such facilities. Experience also shows that women are more comfortable in women-only training environments. Training programmes should be offered free of charge or, in fact, be considered a 'job', in that participants are paid a certain salary as an incentive to participate and increase their education and qualification level. Content in local language is extremely important if ICT are to make a difference in women's lives. It is therefore, extremely important to develop content that addresses local/regional/national needs, to provide information relevant to local/regional/national issues and disseminate that information in appropriate language. It is important to view ICT as a tool to meet women's development needs and accordingly all forms of ICT should be considered to determine which are more appropriate in a particular setting and for a particular programme.

The ways ahead…………..

The advent of ICT has changed the global scenario and many unexplored areas are now open for encashment. It is for us to utilize the benefits to the maximum possible extent. The best part about ICT is that it is capable of various adjustments as per the requirements of the segment using the same. The same can also be adjusted as per the needs and requirement of women in India. So much so that it can be operated from every home irrespective of its location. This means that even the traditional and orthodox families can allow the women to participate and use ICT from their respective homes. In India there is an abundance of "women entrepreneurs" who are capable of making their mark at the global level. However, the awareness and facilities are missing drastically. The national policies and strategies have not yet considered this unexplored potential pool of intellectual inputs. With simple training and awareness programmes we can make a big difference. Further, we can also encourage the establishment of “Small and Medium Enterprises” (SMEs), Small Scale Industries (SSIs), etc. The need of the hour is to show a positive will to achieve that much needed purpose.

Access and costs being some of the greatest barriers for ICT use, it is of the utmost importance to engage women and gender advocates in the policymaking process and dialogue. It is important to engender ICT policy to ensure that women, particularly rural and poor women, benefit from ICT. Hence the question of where and how they can gain access to ICT becomes important. This is an area where intermediary organizations can help. They can ensure that email accounts, bulletin boards, search engines, mailing lists, and other useful functions serve as communication, networking and collaboration channels among women’s groups, and between women and the external sphere. In order to facilitate access for women from other classes and sectors, these intermediary organizations need to be strategically located in local institutions to which women have open and equal access, such as health centers, women’s NGOs, women’s employment centers, libraries, women’s studies departments and institutes, community centers etc. The potential of ICT for women in developing countries is highly dependent upon their levels of technical skill and education and is the principal requirement for accessing knowledge from the global pool. Government and NGOs need to impart technical education on the use of ICT as a part of both formal and informal education system and to initiate distance learning and vocational courses. It needs to be realized that information and communication technology by itself cannot answer all the problems facing women’s development, but it does bring new information resources and can open new communication channels for marginalized communities.

ICTs in Organic farming and sustainable agricultural practices

Dr. S. K. Singh
Principal Scientist, Agronomy

Integration of various information systems (networks) is need of the hour in organic farming and sustainable agricultural practices, which would enable a linkage between research, technology and production. The dissemination of information should be quick enough through information technology so as to gain maximum potential out of it. Globalization is exposing agriculture community to fierce competition. In India only less than 8% of scientific information percolates to farmers and to improve this situation, modern electronic/digital Information & Communication Technologies will have to play a very important role. The modern ICT provided at grass root level will enable farmers (especially small & marginal) to get timely and relevant information for sustainable livelihoods. The internet has become a cost effective source for sharing infinite information, however, the challenge is to how effectively we can create bridge professionals who make use of these advancements for the benefit of farming/rural community and transform these advancements in terms of ensuring food security and fertility of soil. For the farmers point of view Information is the knowledge, communication is getting solution of their problem from knowledge centres, technology is the usage & knowledge of information and communication and organic farming and sustainable agricultural practices are done for ensuring food security and fertility of soil. The initial steps in Information technology have already begun in the agricultural sciences in India long ago with the creation Agricultural Research Information System by the Indian Council of Agricultural Research (ICAR). Still this multifaceted technology has not been utilized to its full extent. The major structural change in agriculture during the past four decades have been mainly directed towards meeting the demands of the growing population, especially in the under developed and developing countries like India. In this process, agriculture became less organic in its technological and practical aspects as high input use played a key role in augmenting food production. Presently, agriculture is at cross roads with higher production envisaged to meet the growing demand for food commodities and emphasis on consuming the natural resources in order to keep the earth green and healthy. As per Kisan Ayog, Bihar,during 1983 per capita cereal consumption per month used to be 15.8 kg. which became 13.0 kg during year 2005. Further, they have also forecasted the cereal consumption to go as low as 12.0 kg per capita per month by the year 2012. More and more consumers want to know what they are eating and whether the products are safe to cosume. There is an increasing appreciation about the quality of food as well as the extent to which the environment is affected by excessive and indiscriminate application of chemicals. Therefore, organic farming is attracting greater attention worldwide. The various factors for successful adoption of organic agriculture in selected areas where they have competitive advantage may be analyzed, and research for generating technologies that support modern organic farming may be strengthened. Such research may not only contribute to enhanced nutritional and environmental security but also improve export prospects in the country. The second green revolution could be termed as knowledge revolution and there are already some visible signs that Asia-Pacific rural Agriculture is in midst of it. The new information and communication technologies (ICTs) are bringing about and sustaining this revolution by empowering the poor farmers with up-to date knowledge and information. ICT is an umbrella that includes the communication devices such as radio, television, cellular phones, computer and network hardware and software, satellite systems and so on. These days reading daily news paper has become regular habit of rural farmers apart from hearing radio and watchin TV, which are very strong source of communication. Many people may not be knowing that deficiency of copper in food may lead to enhancing the cholestrol level in their blood which may cause heart disease. Such informations are being known to the people throgh newspaper/ radio/TV etc. Some of the significant advantages of ICT are timely information on weather forecasts and calamities, better and spontaneous sustainable agricultural practices, better marketing exposure and pricing, reduction of agricultural risks and enhanced incomes, better awareness and information, improved networking and communication, facility of online trading and e-commerce, better representation at various forums, authorities and platform, etc.

Now, very sustainability of agriculture has become a big challenge because we have caused serious damage to our natural resources. Next to water, nutrients are an important input for guiding sustainable growth of agriculture. The N:P:K use in Punjab is 35:9.4:1 while in Haryana and Bihar it is 75:24:1 and 29:5:1 respectively as against recommended level of 4:2:1. The combined use of different sources of plant nutrients i.e. organic, biological and inorganic amendments is important for the maintenance and improvement of soil fertility and plant nutrient supply at an optimum level for desired crop productivity. Unbalanced use of N:P:K have caused deleterious long term effects on soil fertility. In areas subjected to intensive cultivation, application of mere chemicals is not sufficient for sustaining the yields, and it also leads to deficiency in the soil of secondary nutrients and micronutrients which limit crop productivity. Use of organic manure, crop residue and biodegradable rural and urban waste not only supplement the chemical fertilizers but also increase the efficiency in nutrient supply, leading to improvement of physical and biological properties of the soil.

Component Input level Fertilizer equivalent of input in terms on crop yield

Organic manure (FYM) per tonne 3.6 kg N+P2O5+K2O(2:1:1), Green manure (Sesbania) per tonne 4.4 kg N, Green manure (Sesbania) 45 days crop 50-60 kg N for HYV rice, Cowpea intercropped with castor Legume buried 30 kg fertilizer N on castor after 6 weeks, Leucaenia lopping 88 kg N in Leucaenia-25 kg fertilizer N on sorghum, Rhizobium Inoculants 19-22 kg N, Azotobacter and Azospirillum Inoculants 20 kg N, Blue Green Algae 10 kg/ha 20-30 kg N, Azolla 6-12t/ha 3-4 kg N/t, Sugarcane trash 5 t/ha 12 kg N/t and Rice straw + Water hyacinth 5 t/ha 20 kg N/t. The IPNMS helps to restore and sustain soil fertility and crop productivity. It may also help to check the emerging deficiency of nutrients other than NPK. It brings economy and efficiency in fertilizer use and favourably affects the physical, chemical and biological environment of soil. It helps to produce fruits of high nutritional quality in sufficient quantity. The future production scenario, judicious use of chemical fertilizers in combination with organic source of nutrients may play an important role in improving soil health and also help to sustain optimum production of good quality fruits. In country like India to meet out the ever increasing demand of large population for food, we must go for organic farming. But use of organic and inorganic i.e. Integrated Nutrient Management is only the alternative to fulfill the target. It calls for a long term dedication and commitment, both from those who till the land and from those who conduct research and educational programmes to improve and sustain agriculture. Sustainable or regenerative, agriculture will always have to confront the urgencies of time as it also faces the question of how to help feed people profitably. Organic agriculture is often associated with low yields, therefore it is essential to establish certification scheme to facilitate exports of products and accreditation agency to certify the produce of the farm. Farmers experience some loss in yields during conversion period (3-5 years) depending on situation. Drylands are potential place. Medicinal and aromatic plants are first crops for organic farming. It is not possible to meet nutrient requirement of crops entirely from organic sources in India but approximate potential of NPK (15 to 18 m tonnes) is equal to our chemical fertilizer. However, there is significant environmental benefits of Organic farming and the food produced by such land certified as pesticide free are considered as superior in quality as compared to the one produced by using balanced nutrient system. Since organic farm uses several farm grown inputs, and less dependent on market purchased inputs, it is economically attractive to the growers. A case study showed for rice (a) Rs. 11, 250-cost of cultivation when chemicals were used while (b) Rs. 10, 590 when biofertilizer and organic (neem cake etc. used). The output input ratio in modern farming is 3.76 while 4.95 in organic farming.

The available information on organic farming and specially those concerning the sustainable system is very meagre and some of the research undertaken during the era before the use of chemical fertilizers and pesticides has relevance to today's organic farming. Moreover, we must realize that the future progress of the organic farming systems will largely depend on generation of new technology suitable to a particular agroclimatic condition under the present structural set up. The development of sustainable farming systems will require interdisciplinary approach to research on resource conservation, reduced tillage, pest management, crop rotations, improved crop varieties etc. ICTs can also be used for promoting organic farming and sustainable agriculture. The extention functionaries at different levels shall also need to be attuned to the change in farming concept i.e., from energy intensive agriculture to organic agriculture.The scientific literature of organic farming and the character and status of educational materials related to organic farming require inventory, analysis and assessment of the existing reports and professional publications, extention materials, and other sources of information with regard to their relevance and applicability to the informational and educational needs of contemporary organic farmers. High level of illiteracy in most rural areas of the region would require broad band connectivity for audio and visual information exchange. Without this, useful and relevant information content will not be generated and disseminated to the rural population. Telecommunication can play a vital role. With cellular telephony and the internet connectivity individuals and house holds and connecting communities. Kiosks, tele-centres, public call offices and internet cafes and low cost computers and hand held devices are being experimented in India (About 5 lakh villages have been connected by year 2008).

Some of the ICT initiatives which have been taken up in India includes:

1. Help-line services
2. e-Extension (e- Soil Health card Programme): The Deptt. Of Agriculture, Gujarat State is one of the ambitious programmes which aims to analyse the soil of all the villages of the state & proposes to provide online guidance to farmers on their soil health condition, fertilizer usage and alternative cropping pattern. The website is www.agri.gujarat.gov.in, www.shc.gujarat.gov.in.
3. ITC-e- choupal (http://www.echoupal.com).
4. Village Knowledge centre-hybrid wireless network comprising computers, telephones
5. aAQUA (almost All question Answered) is a multilingual online question and answer forum
6. AGRISNET- uses state-of-the-art broadband satellite technology to establish the network within the country. The website is http://www.apgrinet.gov.in for Andhra Pradesh and http://agriculture.up.nic.in for UP.
7. AGMARKNET is a comprehensive database which links together all the important agricultural produce markets in the country (http://www.stockholmchallenge.se/data/agmarknet).

8. Asha services portal offers services on five different sectors of farming- agri., hort., animal husbandary, fisheries and sericulture.
9. Ashwini Project-involves delivery of high quality healthcare,education, agri.,livelihoods training and e-governance to the chosen villages.
10. Community Information Centres(CICs): This project creates awareness among the citizens, particularly those who do not have access to information about the various government scheme.
11. Digital Mandi Project: Creates an exchange for knowledge of farm practices and accurate information for optimizing operations (web site is www.dealindia.org).
12. Digital Ecosystem for Agriculture and rural livelihood- It is a multimedia platform for creation, sharing and dissemination of agricultural information among farmers and experts.
13. Agri Business Centres: It provides a web based solution to the small and medium farmers as well as owners of large landholdings. It brings on a single platform all the stakeholders in agribusiness like farmers and farmer groups,institutions and autonomous bodies, agro machinary and farm equipment makers,cold chain tech., commodity brokers, cooperatives, food processors, pre and post harvest management experts, packaging technology providers, insurance companies, warehousing and logistics agencies,surveyors and certification agencies.
14. e-KRISHI VIPANAN: It professionalize and reorganize the agriculture trading business of Mandi Board by installing cost effective digital infrastructure using latest advancement in ICT by collecting and delivering real time information,online. It makes the operations more effective, totally tranparent,benefiting all stake holders (farmers, traders & the government), empowering them through accurate and timely information for effective decision making.
15. e-krishi(http://www.e-krishi.org)
16. e-Sagu(e-cultivation)system: The eSagu is a ICT-based personalized agro-advisory system.("Sagu" means cultivation in Telugu language). It aims to improve farm productivity by delivering high quality personalized (farm-specific)agro-expert advice in a timely manner to each farm at the farmer's door-steps. In eSagu, the developments in ICT such as (database,internet and digital photography) are extended to improve the performance of agricultural extension services.
17. Query Redress Services: Empowering the farmer community through effective,need-based interventions. It enhances livelihood promotion of farmer community through information dissemination and extension services, using ICT as tool. The project helps the farming community by making available a 10000 plus network of experts to them. Any queries from farmers are forwarded to the ISAP central office from where it is routed to the relevant experts. The service caters to information and knowledge needs of the farmers,professional members of ISAP, individuals and other stakeholders involved in the wider agricultural and allied sectors.
18. Kisan Call Centers: Kisan call centers have been established across the country with a view to leverage the extensive telecom infrastructure in the country to deliver extension services to the farming community.The sole objective is to make agriculture knowledge available at free of cost to the farmers as and when desired.Queries related to agri. And allied sectors are being addressed through the kisan call centres, instantly, in the local language by the experts of agri./hort. Departments,state agril.universities. ICAR institutions etc. There are call centers for every state which are expected to handle traffic from any part of the

    country. SMSs using telephone and computer, interact with farmers to underststnd the problem and answer the queries at a call centre. The infrastructure is placed at three locations namely-a professionally managed call center (level-I), a response center in each organization,where services of SMSs are made available (level-II) and the Nodal Cell (level-III).

19. i Kisan (http://www.ikisan.com)
20. ishakti (http://www.stockholmchallenge.se/data/ishakti_bridging_digital_)

Community Radio Stations (CRS)

Timely availability of reliable information is the key to achieve sustainable food production and mitigate risks. Toward this community radio stations will act as an effective tool of communication and create platform to share experiences, perspectives and innovations to increase yield and reduce labour. ISAP has been identified as one of seven organizations in the country to establish community radio station. It will set up the first radio station at Shironj block of Vidhisa district in Madhya Pradesh. In order to help growers, obtaining required certification for organically produced crops, awareness has to be generated through training and distribution of information material. For adopting organic farming for perennial and non perennial fruit crops, aromatic plants, spices etc., additional assistance will be given @ 50% of cost over and above the area expansion programme limited to Rs. 10,000 per hectare for 4 ha per beneficiary, spread over a period of three years i.e. Rs. 4000/in first year and Rs.3000/per ha each in second and third year. For organic cultivation of vegetables, maximum assistance will be limited to Rs. 10,000/per ha spread over a period of three years. Assistance will be used for generating onfarm inputs. NHM will also provide financial assistance up to a maximum of Rs 5 lakhs for group of farmers, covering an area of 50 ha, duly recommended by State Government, on a case to case basis, for certification of organic process/produce. This assistance will be given over a period of three years @ Rs. 1.50 lakh each in first and second year and Rs. 2 lakh in third year, to meet cost of documentation, training and charges of service provider and certification agencies accredited by APEDA. Comprehensive guidelines already issued in this regard need to be scrupulously followed. For vermi compost units/ organic production units, assistance will be @ 50% of cost subject to a maximum of Rs. 30,000 per beneficiary for a unit having size of 30’ x 8’ x 2.5’. For smaller units, assistance will be on prorata basis. For HDPE Vermibed of 96 cft size (12’x4’x2’), the cost will be Rs. 10,000/per bed. Specification and design parameter of Agro Textiles HDPE woven beds for vermiculture will conform to BIS standards (IS 15907:2010).

ISAP (Indian Society of Agribusiness Professionals) with support of Microsoft - Unlimited Potential Programme has established ‘Community Technology Learning Centres (CTLCs)’ in remote villages of Maharashtra to provide IT training to 45,000 farmers and unemployed youth. Under two-year programme, ISAP would be setting up 250 CTLCs at village level for imparting IT training to rural community and increase their income earning potential.ISAP is working on online weekly price monitoring system of herbal & medicinal plants with the funding support of National Medicinal Plant Board. ISAP gathers and manages authentic data about the weekly price and demand for 101 medicinal plants from 50-marketing centers in different states of the country. These data are weekly upgraded on the basis of prices and quantity offered for different medicinal plants.

ICT Scheme of ICAR: ARISNET (Agricultural Research Information Network)

(www.arisnet.nic.in/ www.icar.org.in)

Indian Council of Agriculture Research (ICAR), under its National Agricultural Research Programme (NARP), initiated establishment of “NICNET based Agricultural Research Information System (ARISNET) in 1990s to network in the Country with the following coverage

:• 89 ICAR Institutions,

• 28 State Agricultural Universities,

• 107 Agricultural University Colleges,

• 564 Krishi Vigyan Kendras and

• 850 Agricultural Research Stations.

Content Scheduling and Management System (CSMS): Mass Media (Nav Krishi) Portal (http://dacnet.nic.in/csms) (A Knowledge Management System for Agricultural Extension Services)

• Agricultural Extension programmes are being produced and telecast by as an average of five days a week for half an hour by a National Channel; Regional Channels and Narrowcasting clusters of Doordarshan (DD) and FM Stations of All India Radio (AIR) in association with Ministry ofAgriculture.

• All Narrowcast centers of DD relay the programme produced by their parent channels.

• To provide a comprehensive and advanced programme schedule; a Content Scheduling & Management System (CSMS); Nav Krishi Portal (G2G & G2C); has been developed by National Informatics Centre (NIC) for reporting and dissemination of Agricultural programmes for the farming community. This will eventually leads to sustainable agricultural development in the country. Agriculture Knowledge & information systems have to be implemented on priority for rural empowerment and improved livelihoods as Economic growth and industrial growth of India are dependent on productivity in agriculture and allied sectors.

Conclusions

A collaborative approach should be adopted for ICT based developments to make use of repository of information available with various organizations. The knowledge delivery should be “demand-driven”. Ministry of Agriculture is implementing various schemes for mainstreaming ICT in Agriculture to improve the Agricultural Productivity on priority. The proposed Common Service Centres and Village Knowledge Centres being set-up by Government of India will further take to harness emerging potential of ICT for the benefit of farmers and all partners of agribusiness offering both synergy and value addition. To provide comprehensive information and advisory services for the benefit. Information services should be made available in regional languages. Bring change in Mindset towards use of ICT. Motivate the people towards building of Comprehensive Database/Information Systems for the farming community. Development of proper advisory services. Development of Expert Systems on What- to- grow-when and where. Bridging the gap through the judicious use of ICT between knowledge and practice for sustainable use of natural resources. Develop linkages between research, technology, and production. Make Reliable and comprehensive Information available any where and any time (one-stop services). The ICON based interactive information Kiosk for computer illiterate farmers for easy, user-freindly, quick/on-line retrieval of relevant information from the concerned research and development as well as extension agencies. Focus be made on the creation and development of web enabled databases, knowledge base management system, datawarehouse by IT experts at NIC in coordination with subject matter specialists keeping a view of requirement of applications for end users, which are the farmers. Fundamental as well as customize class room trainings is required to be imparted at all level of staff at R&D and extension agencies for proper utilization of the IT tools. The services from NIC may be obtained to deal with the trainings issues. Only legal software including legal antivirus solutions must be used for effective asecureutilization of Information Technology. An experienced professional NetworkAdministrator/Database Administrator is the prime need of every organization dealing with scientific information for extension of knowledge to end users through appropriate IT tools. Intranet, within ICAR, may be designed for transparency and effective office management, on the pattern of the Intra NIC developed by the NIC and Intra DAC.

Role of National Informatics Centre (NIC)

Dr. R. C. Bharati
Sr. Scientist, Agril Statistics

This is the age of the Information Technology (IT) revolution. The IT has shown its role in every walks of human activities. The universal acceptance of the power of IT to transform and accelerate the development process, especially in developing economies is indisputable. The rapid advance of Communication technologies, especially the Internet, has enabled governments all over the world to reach out to their most remote constituencies to improve the lives of their most underprivileged citizens. NIC, under the Department of Information Technology of the Government of India, is a premier Science and Technology organization, at the forefront of the active promotion and implementation of Information and Communication Technology (ICT) solutions in the government. NIC has spearheaded the e-Governance drive in the country for the last three decades building a strong foundation for better and more transparent governance and assisting the governments endeavor to reach the unreached. The mid-1970s, in India, were watershed years, heralding a revolutionary transformation in governance. In the year 1975, the Government of India envisioned that the strategic use of Information Technology (IT) in government would lead to more transparent and efficacious governance which could give a fillip to all-round development. In 1976, in the wake of this recognition of the potency of IT, the Government visualized a project of enduring importance viz. the "National Informatics Centre (NIC)". Subsequently, with the financial assistance of the United Nations Development Program (UNDP), NIC was set up. Thus, NIC program was started by the external stimulus of an UNDP project, in the early 1970s, became fully functional in 1977 and since then it has grown with tremendous momentum to become one of India's major Science and Technology organization for promoting information oriented developments. It is a Premier Information Technology Organization in India providing State_of_Art Solutions for Information Management and Decision Support in Government and Corporate Sector. This includes (a) providing network backbone and e-Governance support to Central Government, State Governments, UT Administrations, Districts and other Government bodies and (b) assisting in implementing Information Technology Projects, in close collaboration with Central and State Governments, in the areas such as Centrally sponsored schemes, Central sector schemes, State sector and State sponsored projects, District Administration sponsored projects etc. It is one of the total solution providers to the Government and is actively involved in most of the IT enabled applications. In addition to this, it provides a number of services such as Anti Virus Services, Geographical Information System Services, GOV.IN Domain Registration, Internet Data Centre Services, ICT Training Services, Messaging Services, NICCA Services, SATCOM, Video Conferencing Services, Web Services, Webcast Services etc to all the Government Ministries/Departments / States / Districts.

Anti Virus Services

Anti-virus servers have been deployed across NICNET in every state and Ministry called the Child servers. They are all bound to a central console configured in NICNET HQ called the parent server. Each child server is monitored. Virus can attack a system by opening infected e-mail attachments or downloading infected files. However, this can be prevented by following certain guidelines like installing antivirus software and ensuring regular updates, using software patches to close security loopholes and installing a firewall to prevent unauthorized access to the network.

Geographical Information System Services (GIS)

GIS has emerged as powerful tool which has potential to organize complex spatial environment with tabular relationships. The gives emphasis on developing digital spatial database, using the data sets derived from precise navigation and imaging satellites, aircrafts, digitization of maps and transactional databases. The power and potential of GIS is limited only by ones imagination. The enormous demand for the storage, analysis and display of complex and voluminous data has led, in recent years, to the use of Geographic Information Systems for effective data handling and also for analyzing and geographically transferring the information around the world. NIC offers its users, GISNIC, a software designed to provide a complete state-of-the-art desktop GIs solution for retrieval, projection, transformation and analysis of both spatial and non-spatial data, so that the User is able to manipulate and manage coordinate (locational) and attribute (thematic) data and produce thematic maps as well as tabular reports.

GOV. in Domain Registration

As per the new Internet Domain Name Policy released by the Department of Information Technology, NIC is the exclusive registrar for GOV.IN country level Domain Registration. GOV.IN has been reserved for registering domain names for all the Government Departments/ Institutions / Organizations at various levels right from Central Govt, States & UTs, Districts, Blocks and Panchayats. NIC has also been providing Domain Name Registration under NIC.IN as part of their Internet services since 1995 and has around 8000 domain names already registered. A majority of government ministries and departments including State Governments and District Administrations have registered their domains under NIC.IN domain name. Now, these websites have to be hosted under the 'GOV.IN' domain and NIC is providing this service free of Cost to its users. To facilitate the GOV.IN Domain Registration, NIC has set up an exclusive web site http://registry.gov.in. The domain name registration polices, process and eligibility requirements have also been published on the site. The site also facilitates online registration of 'GOV.IN' Domain Names.

Internet Data Centre Services

Anywhere, anytime availability of government services is an essential requirement for implementation of Electronic governance. Internet Data Centre is a facility that provides extremely reliable and secure infrastructure for running Internet operations round the clock. An Internet Data Centre should essentially have the following features:

- High End Computing Infrastructure
- Storage Networks (SAN/NAS)
- High Speed Local Area
- Multi-Tier Security
- High Speed Internet Connectivity
- Multi level Redundant power back-up
- Air conditioning Management
- Fire Detection & Control System

A wide variety of servers' right from Mail, DNS, Authentication, WWW, Database and Application Servers to Index and Search Server, Media Servers and Traffic Analysis Servers are housed in the Data Centre to provide wide range of Basic and Value added Internet Services to Government departments and organizations at various levels right from Central government to State to district administrations. Number of collocated servers is also housed in the data centre for various nationwide e-governance applications.

ICT Training Services

NIC has been conducting training in key ICT areas, both at the Central Government and State Government level. Accordingly training facilities have been setup at NIC Headquarters (NIC Hq) and NIC State Centre. The district Centre also imparts training as part of on-going projects. The training infra-structure has evolved over several years to cater to various requirements.

Messaging Services

Mails are accepted and sent in NICNET from a single entry point i.e. via the SMTP gateways. Over 8 lakh mails are transacted in a day. Once a mail is accepted in the network, based on its address, it is routed to the recipient server. Messaging services constitute one of the primary applications deployed across the network. They represent the front end of the Network. Hence, Messaging services in NICNET need to integrate the application solution, the underlying network, proactive management and maintenance in a single source solution. The Messaging solution of NICNET is scalable, easily customizable, provisioned for increasing needs while assuring optimum performance, security and reliability. Recently, NIC has rationalized the myriad of e-mail addresses offered by NICNET. The growth of the network services had been going on at an explosive rate and a time had come for streamlining of the e-mail services by adopting a single virtual e-mail server for the whole nation and achieving address resolution in such an environment. Hence, it was decided to give the entire email addressing space in NICNET as "@nic.in". Each network connected to the Internet has a Domain name associated with it, to ensure email and other traffic getting directed to the right recipient. In the case of NICNET, this domain is called "nic.in". All email to the home user is directed to "home.user@nic.in" which will result in the mail being stored on the NIC mail server, ready to be collected by the home user email client.

Video Conferencing Services

Multimedia Systems Lab of National Informatics Centre, was established in September 1992 with the vision of providing low cost Multimedia solutions to the Indian multimedia market. This Lab has been reorganized as Multimedia Engineering and Facilities Division or Videoconferencing Division to provide & maintain NIC Videoconferencing Service. It has also setup a network of 490 Videoconferencing sites over NICNET located at various cities all over India. This network runs on high-speed satellite highway of NIC called NICNET.

Web Services

The Multimedia design lab at NIC is well equipped with state-of-the-art infrastructure including workstations powered with latest tools and technologies useful for designing, developing and deploying multimedia and web applications. The lab is also equipped with latest image capturing and audio/video digitization devices. These tools and technologies are being effectively utilized for graphics design, animation, image capturing, audio/video digitization, multimedia/ web authoring and programming.

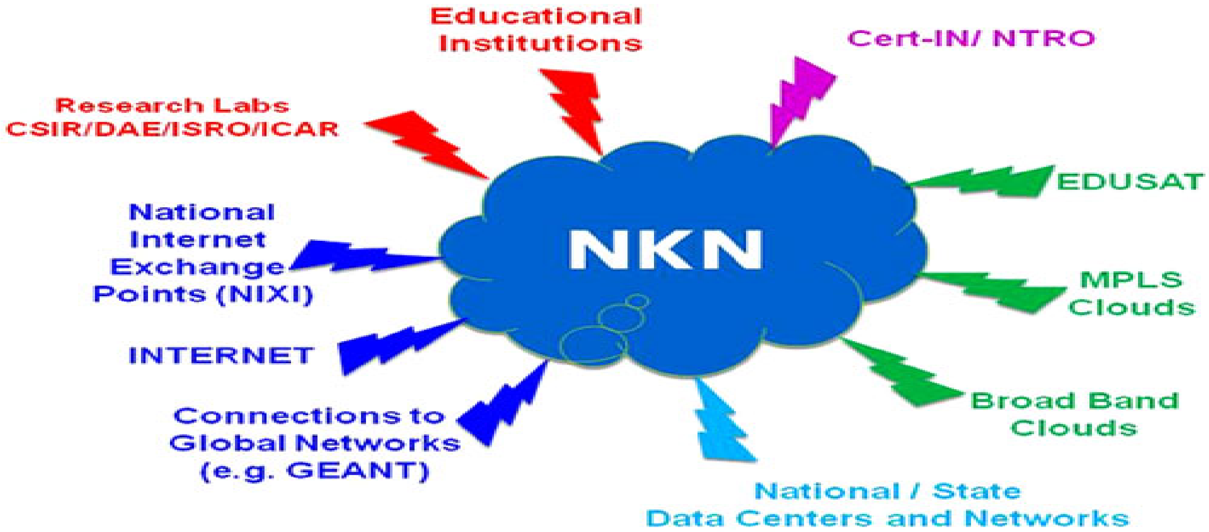
Webcast Services

With the advent of high end streaming media technology, the concept of doing live/on-demand webcast has gained popularity like never before. Webcasting an event allows you to extend the reach of your event to all corners of the world, with no limitations of physical or geographical boundaries.

National Knowledge Network (NKN)

The project NKN is funded by DIT and is currently being managed in multiple phases by National Informatics Centre (NIC). The idea of setting up of a NKN was deliberated at the office of Principal Scientific Advisor to the Government of India and the National Knowledge Commission. Collaborative engagements were held with key stakeholders including experts, potential users, telecom service providers and educational and research institutions. These discussions have yielded a consensus on the optimal approach to be adopted for setting up such a network, to provide a unified high speed network backbone for all the sectors. The Network infrastructure would be itself act as an national level indigenous infrastructure service provider for the various Government bodies, institutions, Colleges, etc. the network is equipped to handle all security measures with the use of advanced and current technologies prevalent in current era. There would be IP (Internet Protocol) based Video surveillance for all the key locations of NKN. NKN is designed as a Next Generation Network backbone, to support the entire education & research communities countrywide. NKN is equipped with state of art latest equipments and bandwidth in tens of gigabits. The NKN network will enable researchers and academia from different background and diverse geographies to work closely for development in critical and emerging areas. It will allow them to share and transfer knowledge at ease. The benefits of such a network go beyond immediate gains as it would rekindle the interest of wider section of research and education institutes in research and development of new technologies. There would be around more than 1000 end-user institutes, bodies and organization would be hooked-up to NKN infrastructure. All the communities of researchers and academicians country-wide would be benefited and make use of NKN infrastructure and eventually make the country benefited in the 21st century. National Knowledge Network (NKN) is one such initiative to enable India to leapfrog to Knowledge Society. It aims at establishing connectivity for Knowledge & Information Sharing by

- Enabling Collaborative Research
- Facilitating personalized life-long leaving education.
- Providing an ultra high speed e-governance backbone
- Creation of unified network which can act as a carrier of all kinds of networks in the field of research, education and governance



Applications of NKN

Countrywide Virtual Classroom: The NKN would be a platform for delivering effective distance education where teachers and students can interact in real time. This is especially significant in a country like India where access to education is limited by factors such as geography, lack of infrastructure facilities etc. The network would also enable co-sharing of information such as classroom lectures, presentations and handouts among different institutions.

Collaborative Research: The NKN would enable collaboration among researchers from different domains. This is one of the key benefits of the proposed network. It will also enable sharing of scientific databases and remote access to advanced research facilities.

Virtual Library: The Virtual Library will enable sharing of journals, books and research papers across different institutions.

Sharing of Computing Resources: High-performance computing is critical for national security, industrial productivity, and science and engineering. The network will enable a large number of institutions to access high-performance computing that can be leveraged to conduct advanced research in areas such as weather monitoring, earthquake engineering and other computationally intensive fields.

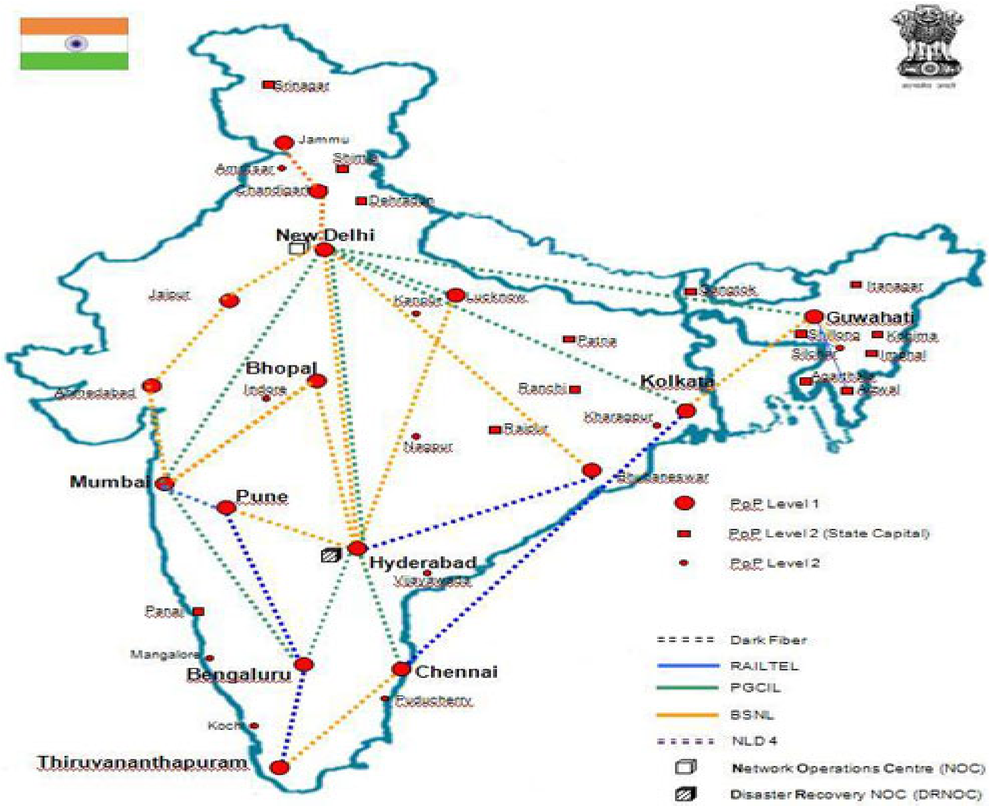
Grid Computing: The NKN will have the capability to handle high bandwidth with low latency and provision to overlay grid computing. Some of the grid based applications that could be realized are climate changes/ global warming, science projects like LHC, Iter, Neartrino etc. One example is the grid computing which has made climate modelling and work related to high energy physics a reality. However, higher bandwidth is required to extend the same over a wider geographical area. The NKN can be the platform to realise such innovative applications.

Network Technology Test-bed: The network would provide test-bed for testing and validation of services before they are made available to the production network. It would also provide facilities to test new hardware, operating system upgrades, vendor inter-operability etc.

E-governance: The NKN will provide high speed backbone connectivity for e-governance infrastructure such as data centres at the national and state levels, and networks (SWANs). The NKN will also provide massive data transfer capabilities required for e-governance applications.

Status of NKN

NKN had already connected and integrated key strategic locations which are also called point-of-presence (PoP). These PoPs had formed a Core Backbone which acts as local gateway for various Education and Research institutes. 80 institutes have been connected in the first phase of NKN including ICAR Research Complex for Eastern Region, Patna with the connectivity of 1 Gbps, IIT;s are making use of virtual classrooms through NKN. The following diagram depicts the current status on NKN.



References

1. www.nkn.in
2. www.home.nic.in

ICT in Dairy Entrepreneurship–Upcoming Initiatives

Awadhesh K. Jha
Sanjay Gandhi Institute of Dairy Science and Technology

Information and Communication Technologies (ICT) play a vital role in generating new ideas, methods, processes and products; as well as in producing socio-economic change. However, it is the commercialization of these new ideas, methods and processes that creates the value for end-users, customers, owners and society at large. To be more precise, the spread of ICT throughout the world has opened up new economic opportunities for marginalized groups, especially in the developing countries like India. Access to ICT and the information resources available through the Internet promise not only social and economic development opportunities to citizens, but help cultivate the entrepreneurial spirit and skills of underprivileged people over the world. In developing and transitional economies, marginalised groups do not lack creativity, but the knowledge and experience to harness ICT so as to improve their professional development and welfare. Today, the information societies are rapidly transforming themselves into knowledge societies. Now, the entrepreneurs, scientists, bureaucrats and politicians are working to get India also on the ICT bandwagon and leapfrog into a knowledge-based economy. A knowledge economy relies intensively on human skills and creativity, the utilisation of human intellectual capital supported by life-long learning and adaptation, the creative exploitation of existing knowledge, and extensive creation of new knowledge through research and development. A country's growth, cultural moorings, its inner strength and competitive edge all depend greatly on ICT power. In India, the significance of ICT in equipping people with new information and skills; and mobilising them for their firm participation in various development programmes and activities has been well recognised and emphasised in the Five Year Plans. In the recent years, the country is on the verge of a new ICT revolution, of which, satellite, TV, and video are major manifestations. Moreover, with the advent of ICT such as high frequency wireless communication, digital compression, microwave communication, silicon chips, satellite communication, optic fibres, telematics, computer graphics, virtual reality, the Internet, World Wide Web (WWW), Internet Protocol TV (IPTV), Interactive TV (ITV), Digital Audio Broadcasting (DAB), multimedia, *etc.*, the whole world is technically intertwined; and the constraints of time and distance having disappeared, the whole world has virtually become a 'global village'. This expert-talk portrays the upcoming ICT initiatives to empower the dairy entrepreneurs in the country.

Information systems for efficient decision makings

Management Information System: The introduction of activities monitoring systems and information systems is required to support the managerial tasks on the dairy farm/factory for compliance with the restrictions and standards such as specific production guidelines, provisions for environmental compliance and management standards. Until now, farmers/small-enterprises have dealt with such a managerial load manually by handling information for decision making. The drastic increase in the use of ICT has reasonably improved and eased the task of handling and processing of internal information as well as acquiring external information. However, the acquisition and analysis of such information still proves to be a challenging task as the information is produced by various sources that may be scattered over different sites and is not necessarily interrelated and collaborated. However, such systems still have to be enhanced in terms of collaboration with automated acquisition of operational farm/enterprise/market data and integration with the overall Farm / Factory Management Information System (FMIS). Advances in precision agriculture including dairying, such as geographical positioning systems and wireless sensor networks for yield and machinery performance monitoring allow farmers to acquire vast amount of site-specific data, which can be used to enhance decision making. Currently, this automatically collected data or data by manual registration are not used due to data logistic problems thereby leaving a gap between the acquiring of such data and the efficient use of the same in dairy management decisions making. The costs of time spent managing the data in many cases outweigh the economical benefits of using the data and it seems that future use of wireless communication will be quite useful. As a whole, a refined and integrated solution to intelligently analyse and transform the acquired data is needed to improve decision making in the future.

Enterprise Resource Planning: Enterprise Resource Planning (ERP) is an integrated information system used to manage internal and external resources, including tangible assets, financial resources, materials, and human resources of a business enterprise. Its purpose is to facilitate the flow of information between all business functions inside the boundaries of the organisation and manage the connections to outside stakeholders. Built on a centralised database and normally utilising a common computing platform, ERP systems consolidate all business operations into a uniform and enterprise-wide system environment. Dairy companies today face a host of challenges and opportunities. The dairy industry struggles with production planning and processing due to the ever-changing quantity and quality of the non-standardised and perishable raw material. Today, companies must increase efficiencies, reduce costs, and ensure compliance with food regulations over the whole supply chain. The ERP solution for the dairy industry provides a single integrated platform that solves the difficult problems posed by multi-vendor, heterogeneous ICT environments. The ERP solution provides streamlined functionality that improves visibility, increases productivity, and helps to regain control of dairy business processes.

Upcoming Mobile and Web technologies

E-learning: India's labor force suffers from a severe shortage of employable skills at all levels and that intensive development of vocational skills will act as a powerful stimulus for employment and self-employment generation. The World Wide Web (WWW) has drastically changed the way of information dissemination especially in the field of education, and in particular for open and distance learning. The relatively small investment required to set up a Website enabled a great many institutions to become instant content providers.

Video-conferencing and online forums: There is a need for more effective agriculture extension system in India. Therefore, the role of extension is undergoing a profound change. ICT-based technologies are helping build better and more effective extension channels, *e.g.*, two-way video-conferencing. Virtual academy is another new platform for extension communication. Virtual academies or colleges can link rural farm communities with researchers, credible intermediaries and markets through an interface of ICT and open/distance learning methods; and host a virtual college of experts through Web-based learning Content Management System (CMS) and link them with various stakeholders.

Data centres: The main concern for various business enterprises is business continuity. Thus, companies rely on their information systems to run their operations. If a system becomes unavailable, company operations may be impaired or stopped completely, *i.e.*, it is necessary to provide a reliable infrastructure for ICT operations, in order to minimise any chance of disruption. Hence, the advent of data centres. A data centre is a facility used to house computer systems and associated components such as telecommunication and storage systems. The main purpose of a data centre is running the applications that handle the core business and operational data of the organisation. Such systems may be proprietary and developed internally by the organisation, or bought from enterprise software vendors.

Telecentres: A telecentre is a public place where people can access computers, the Internet, and other digital technologies that enable them to gather information, create, learn, and communicate with others while they develop essential digital skills. Telecentres exist in almost every country, although they sometimes go by a different name. The Indian initiatives include, Drishtee: one of the largest telecentre networks in India and the world; Common Service Centres, generating employment through capacity building of rural entrepreneurs; Agmarknet Yatra: popularisation campaign of ICT based rural initiative, *etc*.

Agri-business incubator: Entrepreneurship is the strength of sustainable and natural growth for most developed, as well as transitioning and developing economies and incubators have often served as catalysts and even accelerators of entrepreneurial clusters formation and growth. In developing economies like India where incubators can help bridge knowledge, digital, socio-political and even cultural divides and help increase the availability, awareness, accessibility and affordability of financial, human, intellectual, and even social capital, the key ingredients of entrepreneurial success. Incubation has recently experienced increased attention as a model of start-up facilitation. Venture capitalists see incubators as a means to diversify risky investment portfolios, while prospective entrepreneurs approach incubators for start-up support. Incubators are faced with the challenge and the opportunity of managing both investment risks, as well as entrepreneurial risks.

Indian initiatives

Wantrapreneur is such an incubator that provides innovative Social Entrepreneurs focusing on Agriculture, Water, Energy and Dairy with a platform of support and mentoring, enabling them to service the rural poor. It seeks both product-based and service-based business plans in the start-up and early growth phases. It aims to discover people with innovative and entrepreneurial minds looking at market-based models to serve the rural poor. The idea was conceived with the vision of providing social entrepreneurs a window to showcase their innovative product/service models and to provide a supportive environment in order to enable an idea to reach the market and impact thousands of lives.

Technopark Technology Business Incubation Centre, Trivandrum, Kerala offers an e-learning network http://www.ttbi.smartguruji.com. This online platform aims to deliver high quality multi-sensory learning experience for growing entrepreneurs and incubatees and to enhance entrepreneurial talents in a much easier and professional way to all the incubates operating from various locations in the country. This initiative has been launched through National Centre for Innovation, Incubation & Entrepreneurship (NCIIE). This will encourage more and more promising entrepreneurs to start their own enterprise rather than looking for jobs elsewhere. Such a culture will bring a good and healthy change in the country.

Semantic Web: Semantic Web is a group of methods and technologies that allow machines to understand the meaning (or semantics) of information on the WWW. Efforts are on to make the Web capable of analysing all the data, *i.e.*, the content, links and transactions between people and computers on the Web. A 'Semantic Web', which should make this possible, has yet to emerge, but when it does, the day-to-day mechanisms of trade, bureaucracy and daily life will be handled by machines talking to machines! The 'intelligent agents' expected to be materialised in future.

Pervasive computing: Pervasive computing is the trend towards increasingly ubiquitous (also called ubiquitous computing), connected computing devices in the environment, a trend being brought about by a convergence of advanced electronic and wireless-technologies and the Internet. Pervasive computing devices are not personal computers, but very tiny even invisible devices, either mobile or embedded in almost any type of object imaginable, including cars, tools, appliances, clothing and various consumer goods; all communicating through increasingly interconnected networks.

Cloud computing: Cloud computing is Internet-based computing, whereby shared resources, software, and information are provided to computers and other devices on demand, like the electricity grid. Cloud computing describes a new supplement, consumption, and delivery model for ICT services based on the Internet, and it typically involves over-the-Internet provision of dynamically scalable and often virtualized resources..

Concluding remarks

Role of ICT in the operational process, rural development, communication, just in-time services play the major roles in fulfilling the needs to achieve the productivity of their services and products. Hence, the only alternative to empower these villagers is to use ICT tools in bridging these gaps in their day-to-day lifestyle and its bottlenecks. Also, the ICT can help surmount barriers present in providing information resources at a low cost and make applications feasible and profitable.

Role of ICTs in weather forecasting under changing agro-climatic condition

Dr. N. Subash
Scientist (SS) (Agricultural Meteorology)

Meteorology is the science of Atmosphere. Atmosphere is a thin layer of gases surrounding the Earth which enables sustenance of all forms of life. All weather and climate processes occur in the atmosphere mainly below 15 Km. The science and systematic study of meteorology/weather began in the 17th century,

- with the industrial revolution
- with the scientific invention of instruments (mercury thermometer, barometer and anemometer, etc)
- tele-communication like telegraph
- the formation of laws governing the behavior of atmospheric gases
- map projections, etc.
- scientific development of fluid dynamics.

Weather has no political boundaries. Any weather affecting a particular place can affect the weather in other areas due to it's systematic movement and also due to their tele-connections. Understanding and forecasting weather over a particular place requires understanding of weather in a broader region. Quick and reliable communication is sine-qua-non in any weather service. The science of Meteorology owes its development and advancement only to technical advancement of Information and communication technology. Thus ICT plays a very crucial role. Public awareness and exploitation for location/time specific forecast of warnings is also are the increasing due to advancement in information and communication technology

The weather service has five components in all in which communication and information and technology play a major role

- Weather observations
- Quick exchange of weather observations
- Analysis of weather data
- Diagnosis / Prognosis / forecast, Weather warnings and their dissemination
- Archival of weather Data for climatology, research and training.

Every aspect of human activity from agriculture to aviation, and sports to space flight depends on weather. The issue of early warning and forecasts is perhaps the most challenging activity of any meteorological service. In India, India Meteorological Department is the service provider for our country. Figure 1 depicts the different sectors of India using IMD weather forecast.

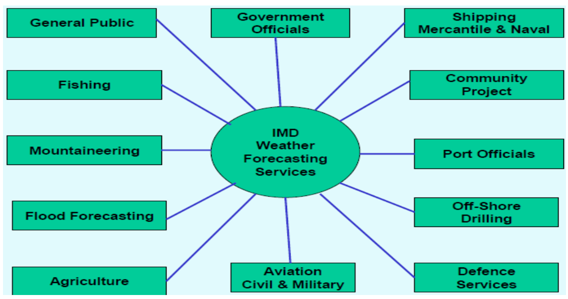


Figure 1. Weather forecasting and different sectors

Weather forecasting and warning has always been a challenging task. More so with reference to India due to varied climatic conditions ranging from tropics to extra tropics. Major Weather Systems Affecting Our Country

GLOBAL SCALE : (>1000 kms)

- Planetary Waves
- ITCZ (Inter Tropical Convergence
Zone)

REGIONAL SCALE : (>1000 kms)

MONSOONS
– South West Monsoon (June – Sept.) – Affects the entire country.
– North East Monsoon (OCT – DEC) – Main Influence over TAMIL NADU, ANDHRA PRADESH, INTERIOR KARNATAKA.

SYNOPTIC – SCALE : (100 – 1000 kms)

– CYCLONIC STORMS :- Affects entire Coastal Area.
Seasons : (APRIL – MAY) & (OCT – DEC)
– MONSOON DEPRESSIONS & LOWS : JUNE – SEPT.
Normally form over Head Bay & move across the country in WNW Direction.
– WESTERN DISTURBANCES : NOV – DEC, JAN – MAY. (mainly winter Season)
Intense Low Pressure systems moving west to east across northern India, Mainly affects NW parts of our country.
– NOR WESTERS : Intense Thunderstorm activities over NE India –Bengal
HOT WEATHER SEASON (Mainly, APRIL – MAY)
– DUST STORMS / SAND STORMS. (Mainly, APRIL – MAY)
– TROUGHS LOW PRESSURES :
– UPPER AIR TROUGH IN WESTERLIES
– SURFACE & LOW LEVEL TROUGHS.

SUB SYNOPTIC SCALE : (>10, <100 kms)
– Off shore / On set vortices (beginning of SW monsoon rain)
– Squall lines.
MESO SCALE : (Tens of kms)
– Local Thunder storms.
– Sea Land Breeze Effect
– Tornadoes
MICRO SCALE : (Only a very few kms)
– Cloud Bursts.
– Micro Bursts.
– Dust Devils.
– Dust Raising Winds.

Weather plays an important role in agricultural production. It has a profound influence on the growth, development and yields of a crop, incidence of pests and diseases, water needs and fertilizer requirements in terms of differences in nutrient mobilization due to water stresses and timeliness and effectiveness of prophylactic and cultural operations on crops. Weather aberrations may cause (i) physical damage to crops and (ii) soil erosion. The quality of crop produce during movement from field to storage and transport to market depends on weather. Bad weather may affect the quality of produce during transport and viability and vigor of seeds and planting material during storage. Agrometeorological weather forecasting covers all aspects of forecasting in agrometeorology. Therefore, the scope of agrometeorological forecasting very largely coincides with the scope of agrometeorology itself. In addition, all on-farm and regional agrometeorological planning implies some form of impact forecasting, at least implicitly, so that decision-support tools and forecasting tools largely overlap.

A deterministic definition states that "weather forecast describes the anticipated meteorological conditions for a specified place (or area) and period of time"; an alternative and more probabilistic definition states that "weather forecast is an expression of probability of a particular future state of the atmospheric system in a given point or territory". In view of the above a Weather forecast may be defined as a declaration in advance of the likelihood of occurrence of future weather event(s) or condition(s) in a specified area(s) at given time-period(s) on the basis of (i) a rational study of synoptic, three-dimensional and time-series data of sufficient spatial coverage of weather parameters and (ii) analyses of correlated meteorological conditions. The positive effect of weather forecasts in agriculture is maximized if weather forecasters are aware of the farmer's requirements and farmers know how to make the most use of the forecasts that are available. Response amongst varieties of a crop to weather phenomenon is one of degree rather than of type. However, the type and intensity of weather phenomenon that cause setbacks to crops vary amongst crops and with the same crop with its growth stages. Because of crop-weather reasons, crops and cropping practices vary across areas even in the same season.

In the provision of weather forecasts for agriculture the emphasis should be on the look out for incidence of abnormal weather and prevalence of aberrant crop situations. Now, one cannot determine abnormality unless one knows what the normal picture is, both with reference to crops and weather. Thus, the first step in familiarizing the weather forecasters with the weather warning requirements of farmers is the preparation of "Crop Guides to Forecasters" (i) giving the times of occurrence and duration of developmental phases from sowing to harvest of major crops in the regions of their forecast interest and (ii) specifying the types of weather phenomenon for which weather warnings and forecasts are to be issued in the different crop Phases. Such guides can be used by the forecasters to prepare period-wise, region-wise calendars of agricultural weather warnings. In the crop guide to forecasters normal values of important weather elements in the crop season, for the national short-time period adopted for agro meteorological work, should also be given and such guides made available to the farming community so that any farmer will know immediately the normal features of weather for a given crop and season in his place. The week is the accepted time-unit for agro meteorological work in India. The Crop-weather calendars in use in India, using the week as the time-unit, vide a sample depicted in Figure 1 are excellent examples of the type of compiled information that would assist forecasters in framing weather warnings and forecasts for use of farmers. In weather forecasting we now have a very wide range of operational products that traditionally are classified in the following groups:

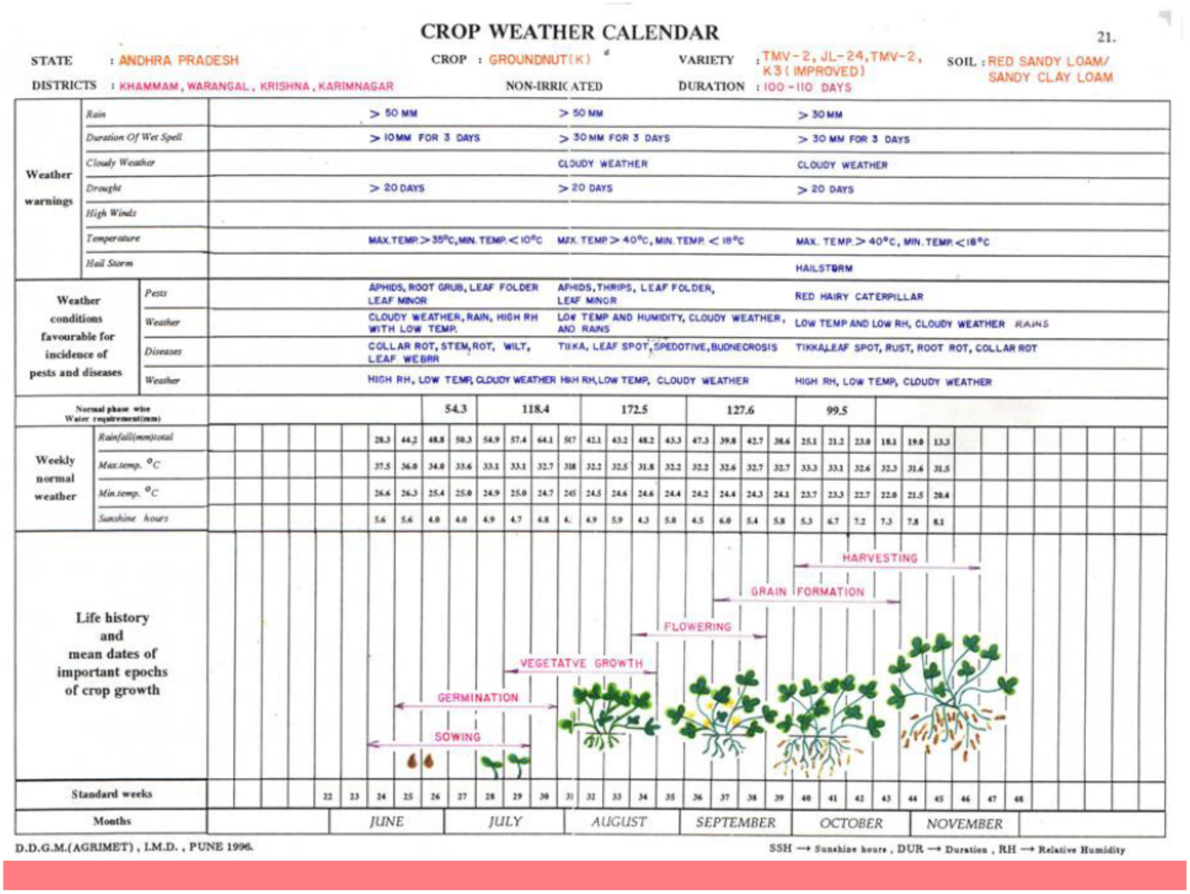


Figure 2. A crop weather calendar

In weather forecasting we now have a very wide range of operational products that traditionally are classified in the following groups:

1. ***Now-casting (NC)***

It is valid within 16 hours. Major application in

– Aviation (for heavy rainfall, severe thunderstorm, squall,Tornadoes & other convective activities main tool Radar)

– Earthquake reporting.

– Relief and rescue operations (in case of calamities and disasters like oil spill / oil well fires / cyclone and flood management).

2. ***Short Range Forecast (SRF)***

Based on synoptic methods, weather charts are plotted and analysed using Indian and global data. After identification of weather systems, its movement / intensity / development prognosticated. The charts are now plotted automatically at many centers. The main advantage is it eliminates human error and ensures speed.

3. ***Medium Range Forecast (MRF)***

Mainly for agricultural purposes. This forecast varies from 3 to 1 week. Advisories from NCMRWF is disseminated to various agricultural centres/users. Based on the numerical statistical models which involve following steps:

a) Initialisation
b) Data Assimilation
c) Running Numerical Model
d) Interpretation of Model output.

All these stages make use of ICT. The data assimilation and running of numerical models are done using very high-speed computers/ workstations having high computing power. The model results are interpreted through various statistical packages.

4. Long Range Forecast (LRF)

Used for issuance of monsoon forecast (both SW and NE) by IMD. Forecasts issued in mid April and with update in late June or early July.
Two types
Statistical: 8 parameter regression model (Deterministic and Probabilistic)
Dynamical: To run the models, very high speed computing power is needed to process the data. Initialize the model, provide boundary conditions then it obtains the results and interpret them. All these functions are effectively obtained through advances in ICT.

Another type of forecasting is called HINDCASTING, which is based on climatology. It is used for
– Future planning activity.
– Post analysis for improving future prediction capabilities.
– Research for weather related disaster managements, etc.
– Climatic change and identification of trends and periodicities.
– Environmental issues like ozone depletion, storm surge estimates, coastal inundation, etc.

Areas of applications of ICT in Weather Forecasting

- Monitoring and Observations
- Speedy exchange of data-facilitating enhanced lead time for forecast preparation
- Automatic Plotting and Analysis of Met. Data
- Exchange of Analyzed Weather Maps and other information through Internet
- For Computational Facilities: Workstations, Advanced versions of Computers

Advantages

- Enhanced Speed of exchange of data and information
- Higher accuracy
- Minimized human errors
- Better finishing to forecast end-products facilitating quick and effective assimilation by users
- Scope for Modifications

Access to Weather Information, Disaster Early Warning and Country Preparedness

The poor, especially the rural poor, are particularly vulnerable to the negative effects of extreme weather and natural disasters. Yet accurate forecasting and timely warning can mitigate the effects of natural disasters such as floods, and improved weather forecasting can improve crop yields and lessen the effects of severe weather or drought. ICT has a crucial role to play in all links of the chain, from detection to modeling and forecasting to advance warning and localization. Yet the vast majority of the poor in developing countries still have very poor access to such information and very little advance warning of adverse events. Accurate forecasting, and the increasingly sophisticated computer models that undergird it, depend on a vast array of data at a global scale, and national meteorological organizations play a key role both as suppliers of data for global forecasting and as consumers of information and forecasting that they localize and share. The costs of upgrading meteorological detection, analysis and reporting systems is substantial, but the benefits of improved forecasting and advance warning are substantial and have a strong pro-poor impact. For this reason, there is a strong case to be made for international donors to partner with governments and local partners to invest in improving and upgrading these systems and assuring that the poor, particularly the rural poor, obtain more timely and accurate weather and natural disaster information.

Agricultural advisories or Agro meteorological services

"Agricultural advisories" or Agrometeorological Services is an act of advice by internal experts of various disciplines on the basis of possible future weather and climate conditions on "what to do" or "what not to do" for maximizing the advantages and minimizing the losses in production. Weather and climate forecasts have little importance unless they are operationally used. For maximum advantage of weather forecasts, agrometeorological advisories are issued in consultation with experts of other concerned disciplines and considering the past, present and predicted weather and its spatial-temporal behaviour. Any appropriate forecast on weather has tremendous benefits in terms of pre-facto management of the negative impacts of vagaries of weather. This is because the cost of pre-facto risk reduction due to weather is much smaller than the post-facto management of the losses (Rathore et al., 2006). These advisories recommend (i) implementation of certain practices or the use of special materials to help effectively prevent or minimize possible weather-related crop damage or loss, e.g. spraying advice based upon past and forecasted weather conditions to combat crop diseases and insects; sowing advice for better germination and plant stand; harvesting advice to obtain optimum crop maturity and quality etc and (ii) initiation of cultural practices which are weather sensitive.

The formation of agrometeorological services in forecasting requires close linking of various data-providers and expertise from different fields. The basic requirement is that the forecasted data must be for the desired period and for the specific location under consideration. The National Centre for Medium Range Weather Forecasting, NCMRWF in India for example provides from a T-80 General Circulation Model location-specific weather forecast for six parameters, viz. rainfall, cloud cover, wind direction and speed, and minimum and maximum temperature twice a week with a resolution of 150 km x 150 km. These forecasts are further subjected to statistical and synoptic interpretation (Rathore et al., 2006). A panel of experts then discuss the present, past and future status of weather and crop conditions and recommend the appropriate operations for better farm management based on such forecasts. Priority is given to predominant crops of the region and most prevailing problems keeping in view the relative economic importance. Management practices like what, when and how to sow; when and how much to irrigate; what measures to be adopted for plant and animal protection from stresses caused by pest and disease, temperature, wind, and rainfall etc are suggested. Animal shelter, nutrition and their health are affected by weather to a large extent and hence must find a place in the services. On the basis of local agrometeorological and farming information and the weather forecasts, the subject matter specialists discuss the options and consequent effects and then decide the advises for the action by the farmers in respect of the items related to their expertise. All these together constitute the agricultural advisory.

Information requirements

Weather information: weather information required for services involve weather summary of the recent past, for example the preceding week, climatic normals for the advisory period, and weather forecasts for the advisory period.

Agrometeorological information: this includes some indices related to agricultural production such as Crop Moisture Index, Drought Severity Index for the recent past.

Crop Information: the information on present crop status is very important for the preparation of advisories, which contains type, state, and phenological stage of crops; infestation of pest and diseases and their severity; other crop stresses such as nutrient stress, water stress, thermal stress etc.

Soil information: the preparation of advisories also takes account of the spatial distribution of soils. The information on soil types, physico-chemical properties, nutrient status of soils, moisture status, elevation, contour and slope of soils is required for preparation of advisories.

Other information: information on topography of the region, land cover and land use, irrigation facilities, irrigated and rainfed areas, availability of agricultural inputs and market trends are also considered for preparation of advisories.

Dissemination of Met Information and Weather Warnings

IMD through its various forecasting centres disseminates weather bulletins/ forecast/ Warnings as a routine daily twice. Disseminates through regular communication channels to various user agencies/general public, etc. During cyclones and depressions they are issued frequently. With the advent of technology, data and information exchange being carried out through AMSS, Internet, Satellite phones (important when all modes of communication fail, like during cyclones) etc.

References

Rathore, L.S., Parvinder, M., Kaushik, S., 2006. Impact assessment of the agro-meteorological advisory service of the National Centre for Medium Range Weather Forecast (NCMRWF). Available on the INSAM website (www.agrometeorology.org) under “Accounts of operational agrometeorology”.

Role of ICTs in rural development with reference to changing climatic conditions

Dr. Abhay Kumar
Senior Scientist, Agril. Statistics

Agriculture is an important sector with more than 70% of the Indian population living in rural areas and earns its live hood by agriculture and allied means of income. The sector faces major challenges of enhancing production in a situation of dwindling natural resources necessary for production. The growing demand for agricultural products, however, also offers opportunities for producers to sustain and improve their livelihoods. Information and communication technologies (ICT) play an important role in addressing these challenges and uplifting the livelihoods of the rural poor. ICT offers an opportunity to introduce new activities, new services and applications into rural areas or to enhance existing services. ICT can be interpreted broadly as “technologies that facilitate communication and the processing and transmission of information by electronic means.” ICT promises a fundamental change in all aspects of our lives, including knowledge dissemination, social interaction, economic and business practices, political engagement, media, education, health, leisure and entertainment. In India ICT applications such as Warana, Dristee, Sari, Sks, E-Chaupal, Cybermohalla, Bhoomi, E-Mitra, Deesha, Star, Setu, Friends, E-Seva, Lokmitra, E-Post, Gramdoot, Dyandoot, Tarahaat, Dhan, Akshaya, Honeybee, Praja are in functioning for rural development. ICTs can play a significant role in combating rural and urban poverty and fostering sustainable development through creating information rich societies and supporting livelihoods. If ICTs are appropriately deployed and realize the differential needs of urban and rural people, they can become powerful tools of economic, social and political empowerment.

ICT and rural development:

Rural Development forms an important agenda of the Government. However, the uptake of e-governance in the Rural Development sector has been relatively slow. The main reasons for this are poor ICT infrastructure in rural areas, poor ICT awareness among agency officials working in rural areas and local language issues. Efforts are, however, on to extend infrastructure up to village level. Already, many states have gone ahead to provide connectivity up to block level. This has helped in taking the e-governance efforts further closer to the people. The important requirement of establishing infrastructure in rural areas is now being taken up as a high-agenda project after the President of India envisioned the idea of providing urban amenities in rural areas (PURA). PURA (Provision of urban amenities in Rural Areas) has been conceived as a scheme under MoRD and envisages to achieve its objective by bridging the various kinds of divide that exists between rural and urban areas by providing four major kinds of connectivity to rural areas: physical (road, power), electronic (telecommunication, internet), knowledge and market. With the provision of such connectivity, it is hoped that the benefits of e-governance in the Rural Development sector would reach its true beneficiaries.

The agricultural sector is confronted with the major challenge of increasing production to feed a growing and increasingly prosperous population in a situation of decreasing availability of natural resources. Factors of particular concern are water shortages, declining soil fertility, effects of climate change and rapid decrease of fertile agricultural lands due to urbanisation. However, the growing demand, including for higher quality products, also offers opportunities for improving the livelihoods of rural communities. Realising these opportunities requires compliance with more stringent quality standards and regulations for the production and handling of agricultural produce. New approaches and technical innovations are required to cope with these challenges and to enhance the livelihoods of the rural population. The role of ICT to enhance food security and support rural livelihoods is increasingly recognised and was officially endorsed at the World Summit on the Information Society (WSIS) 2003-2005. This includes the use of computers, internet, geographical information systems, mobile phones, as well as traditional media such as radio or TV. Although it is a relatively new phenomenon, evidence of the contribution of ICT to agricultural development and poverty alleviation is becoming increasingly available.

ICT and agriculture:

The vast majority of poor people lives in rural areas and derives their livelihoods directly or indirectly from agriculture. Increasing the efficiency, productivity and sustainability of small-scale farms is an area where ICT can make a significant contribution. Farming involves risks and uncertainties, with farmers facing many threats from poor soils, drought, erosion and pests. ICTs can deliver useful information to farmers about agriculture like crop care and animal husbandry, fertilizer and feedstock inputs, pest control, seed sourcing and market prices.

ICT for Education:

Moreover, appropriate use of ICTs in the classroom fosters critical, integrative and contextual teaching and learning; develops information literacy (the ability to locate, evaluate and use information). Thus, it improves the overall efficiency of the delivery of education in schools and educational management institutions at the national, state/provincial and community level. The use of ICTs in education aims to improve the quality of teaching and learning as well as democratize the access to education.

ICT for Economic Development:

Information and Communication Technology has a vital role in connecting the rural community to outside world for exchange of information, a basic necessity for economic development. Effective use of ICT can demolish geographical boundaries and can bring rural communities closer to global economic systems and be of meaningful help to the underprivileged.

Employment Opportunities:

Poor people in rural localities have lack of opportunities for employment because they often do not have access to information about them. One use of ICTs is to provide on-line services for job placement through electronic labor exchanges in public employment service or other placement agencies.

ICT in e-Governance:

The poverty can be adequately addressed by effective use of e-governance and ICT application in environmental management. Improved governance by using ICT can have direct impact in reducing poverty and improving the environment. ICT can contribute in a large way in making government processes more efficient and transparent by encouraging communication and information sharing among rural and marginalized people.

ICT in Capacity-building and empowerment

Communities and farmer organizations can be helped through the use of ICTs to strengthen their own capacities and better represent their constituencies when negotiating input and output prices, land claims, resource rights and infrastructure projects. ICT enables rural communities to interact with other stakeholders, thus reducing social isolation. It widens the perspective of local communities in terms of national or global developments, opens up new business opportunities and allows easier contact with friends and relatives. A role is also played by ICT in making processes more efficient and transparent. It helps in making laws and land titles more accessible. Global Positioning Systems (GPS) linked to Geographical Information Systems (GIS), digital cameras and internet, help rural communities to document and communicate their situation. Rural communities benefit from better access to credit and rural banking facilities. Recent mobile banking initiatives offer further scope to reduce costs and stimulate local trade. The Indian AMUL programme automates milk collection and payments for its 500,000 members, thereby enhancing transparency of the milk volume and quality collected and ensuring fair payments to farmers.

ICT and Service delivery mechanisms:

There is a huge gap between information residing in agricultural knowledge centres and rural communities. At local level, multi-stakeholder mechanisms are important to make relevant information accessible to end users. Intermediary organizations have to connect rural communities to available knowledge. Users will increasingly want tailor-made, quality answers to their questions. In the Agricultural Clinics in India customers get answers within one to two days. Mobile Q&A services are being piloted in India. At national level, mechanisms need to be in place to ensure learning and information sharing. The type of ICT used by local communities is subject to rapid change. However, broadband internet access is seen as central for societal innovation because storing of large datasets and live communication requires good connectivity. Until recently, connectivity in rural areas was limited to slow dial-up lines. Satellite connections now make broadband access possible in remote areas. Use of mobile phones has seen an enormous increase in recent years. Nevertheless, big differences still exist in broadband access between developed and developing countries. New wireless technologies such as MESH and WiMAX, and new-generation mobile phone networks, will provide high speed internet services at sharply reduced costs, thereby dramatically increasing internet coverage in rural areas.

ICT and Health:

Health care is one of the most promising areas for poverty alleviation. ICTs are being used in India to facilitate remote consultation, diagnosis and treatment. Delivering health care with ICTs enables health care professionals and institutions to address the critical medical needs of rural communities, especially those in remote locations and those that lack qualified medical personnel and services.

ICTs and climate change resilience

The role of ICTs in climate change resilience can be explored based on the linkages that exist between ICTs as a system component, and the set of resilience sub-properties viz., Robustness, Scale, Redundancy, Rapidity, Flexibility, Self-organization, and Learning. The first – robustness – relates mainly to the ability to withstand. The others relate mainly to the ability to recover and to change. In narrow, ‘dictionary’ terms, resilience means the ability to ‘bounce back’; that is, to recover to some original state following an external disturbance. Those sub properties are a function of the system’s components, and they enable it cope (with climate change). Coping is the ability to withstand external shocks, and the ability to adapt to shocks and trends. Adaptation, in turn, includes not only recovery from short term climate change related shocks but also change in the face of longer terms climate trends; those changes including both response to threat but also grasping of potential opportunities from climate change. Thus, adaptive capacity relates just to the six latter properties, while resilience relates to those six plus robustness.

ICTs and Robustness

ICTs can help strengthen the physical preparedness of livelihood systems for climate change related events through applications such as geographic information systems (GIS), and positioning and modelling applications. These can contribute to design of defenses and determination of their optimal location; both making the livelihood system more robust. ICTs can also strengthen institutions and organisations needed for the system to withstand the occurrence of climatic events, including the support of social networks and the facilitation of coordinated action (Duncombe, 2006). For example, ICTs can strengthen social networks through enhanced communication within those networks; communication that increases the network bonds by building trust and a sharing of norms and values.

ICTs and Scale

ICTs can help increase the breadth and depth of assets to which households, communities, etc have access. ICT can facilitate access to a broader set of capital assets, fostering the ability of livelihood systems to recover from climate related events. Illustrating this potential, ICTs available in Village Resource Centres in rural India have enabled end users to interact with scientists, doctors, professors and government officials located in urban locations (Nanda and Arunachalam, 2009). This has increased the information assets available (e.g. oceanic weather forecasts), and human capital (e.g. via telehealth and elearning), all of which help when climate related events occur. ICTs can increase the scale of available assets by combining the distant and theproximate. In relation to information assets, for example, in remote areas of the Philippines, participatory 3dimensional modelling- a community based tool which merges GIS generated data and local peoples' knowledge to produce relief models – is being used to establish visual relations between resources, tenure, their use and jurisdiction, thus contributing to the ability of the community to dealwith climate change hazards and trends (IAPAD, 2010). Mobile applications have improved the breadth of structural access by enabling integration of local producers – small entrepreneurs and farmers – into regional and global supply chains, which also broadens the scale of asset availability, typically in terms of financial and physical capital.

ICTs and Redundancy

Redundancy with respect to ICTs refers to the potential of these tools to increase the availability of resources to such an extent that there is some spare, excess or possible substitutability of assets. One of the key ways in which ICTs can contribute towards system redundancy is by supporting access to additional financial capital. Mobile phone and Internet usage among farmers has been found to increase their participation in markets and provide information for improved productivity. This may enable the generation of spare income usable in strengthening local preparedness and response in the event of climatic events (e.g. buying additional food to store, or improving the building structure of the household). Likewise, the advent of mfinance systems has facilitated remittance flows which may be called upon during an acute shock to substitute for income that can no longer be produced locally, thus offering some measure of redundancy. One example is the broadening of job markets through use of ICTs such as mobile applications (e.g. job searching mechanisms such as Babajob, which uses web applications and mobile technology to connect informal sector workers-maids, cooks, drivers, etc – with potential employers in India) (Babajob, 2010; VanSandt et al., 2010). Then, if there was a collapse or failure of the informal networks through which most poor people find jobs, the spare capacity provided by the ICT system can enable continued operation.

ICTs and Rapidity

ICTs can enable swift access and mobilization of financial assets, particularly through applications for mobile banking and mobile finance (Duncombe and Boateng, 2009). By enabling rapid access to financial capital and transactions, ICTs have the potential not only to strengthen local livelihoods but also to improve the speed and efficiency with which local communities are able to cope with and adapt to climate change related hazards and events. ICTs can also speed up access to information. This is particularly important when an acute climate related shock such as landslide or flood occurs. Mobile based telecommunications networks allow rapid communication of information, thus improving the speed of disaster warning, response and recovery (Aziz et al., 2009; Samarajiva & Waidyanatha, 2009)

ICTs and Flexibility

Within vulnerable livelihood systems, ICTs can help identify and undertake different actions to better withstand the effect of climate change related events, and utilise the opportunities that may arise from change. Identification of diverse action possibilities arises from the sharing of knowledge – something that ICTs are particularly good at – by enhancing the social contacts that provide access to tacit knowledge; and by enhancing access to the explicit knowledge that is now held, for example, on web sites and e-learning systems worldwide. Access to information can also promote flexibility through identification of alternative possibilities, such as information about different income generating opportunities including information on demand and prices at different markets. The multi-functionality of ICTs themselves can also be argued to introduce greater flexibility into the livelihood systems of which they become a part and, perhaps, to encourage flexibility by embodying it as an inscribed value. That inherent quality of ICTs may enable greater flexibility of action where ICTs are part of the action processes within a livelihood system, as they increasingly are in relation to not just communication but also transactional processes such as finance, banking, education, and health. Where ICTs form part of a livelihood, the technology's flexibility can enable livelihood flexibility; for example, the ability to diversify relatively easily from one form of ICT activity (e.g. data entry) to another (e.g. digital photography) (e.g. Heeks and Arun, 2010).

ICTs and Self Organisation

ICTs can enable access to the set of resources that livelihood systems require to effectively self organise in the event of climate change related shocks or disturbances. ICTs provide access to relevant data and information that is first processed at an individual level (cognition), then facilitate communication and interaction between a wide range of stakeholders, and ultimately enable cooperation, which can translate into adaptive actions being implemented with the participation of a wide range of stakeholders. Exemplifying this multistage influence in self organisation, in the Philippines SMS is being used for citizen engagement campaigns that seek to reduce air pollution while encouraging citizen participation (Dongtotsang and Sagun, 2006), suggesting the potential of these tools to foster environmental action and raise policy awareness.

In cases such as this, ICTs can play a role from accessing relevant data and awareness on environmental issues at the individual level, to enabling communication and interaction using mobile telephony, to fostering cooperation with wider networks of stakeholders towards action, through social networking tools and the strengthening of participatory processes.

ICTs and Learning

Experiences from the field suggest the role of ICT enabled skills and access to knowledge in enhancing the capacities of local actors and empowering marginalized groups (Labelle et al., 2008). We may conceive this role in relation to the cycle of experiential learning that, according to Kolb (1984), involves four elements: concrete experience, reflective observation, abstract conceptualization and active experimentation. ICTs can particularly facilitate reflection and thinking–the key constituents of systemic feedback–but will impact the whole cycle. For example, Web 2.0 and new media applications can turn this into a collective learning process (GTZ, 2008). By sharing observations and reflections through ICT tools (e.g. blogs, wikis, environmental observations and monitoring), users foster new ways of assimilating or translating information (e.g. changes in their natural environment), which can be shared through wider networks, and then influence action (e.g. encourage testing or experimentation), enabling new experiences/practices to take place. This generation of new and broader learning cycles will in turn strengthen systemic resilience. This potential is reflected in initiatives such as the DEAL project in India, which aims to create a digital knowledge base by involving various actors in the content creation process, while making this knowledge accessible to farmers and other agricultural practitioners (DEAL, 2010). Based on the use of Web 2.0 tools, it provides a way for the farmers to explain their problems and establish a dialogue with scientists and researchers through an audio blog. The blog captures tacit, experiential knowledge from the farmers through uploaded audio files, while ensuring collaborative practices for reflection, knowledge generation and reuse through action (GTZ, 2008). In this way, ICTs can expose the collective experience of rural farmers and existent traditional knowledge, which plays a critical role in the success of adaptation, while fostering new learning processes on issues that are key for the sustainability of local livelihoods amidst a changing climate.

References:

Annual report, 2002-2003, Ministry of Rural Development Government of India

E-Seva, an information brochure of Department of Information Technology and communications 2001

http://ruralinformatics.nic.in 'Information and communications Technology for Development' A source book for Parliamentarians Rural Informatics in India – An approach paper

Nayak, S. K.; Throat, S. B. and Kalyankar, N. V. (2010), Reaching the unreached: A Role of ICT in sustainable Rural development, International Journal of Computer Science and Information Security, Vol. 7, No. 1, pp. 220-224.

Angelica Valeria Ospina & Richard Heeks (2010), Linking ICTs and Climate Change Adaptation: A Conceptual Framework for eResilience and eAdaptation, Centre for Development Informatics, Institute for Development Policy and Management, SED, University of Manchester, UK.

Gujarathi, D. M. and Patil R. S. (2009), Role of ICT and e-governance for Rural Development, International Referred Research Journal ISSN- 0975-3486 Vol. I Issue -9 (RNI: RAJBIL /2009/30097)

Bhatnagar S.C., E-Government : From Vision to Implementation – A Practical Guide with Case Studies, SAGE Publications Pvt. Ltd., New Delhi, 2004.

Obayelu A. Elijah and Ogunlade, I.(2006), Analysis of the uses of information and communication technology for gender empowerment and sustainable poverty alleviation in Nigeria, International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2006, Vol. 2, Issue 3, pp. 45-69.

Role of ICTs in transfer of technology: Challenges of the developing world threatened by climate change

Dr. M. S. Meena
Senior Scientist (Agricultural Extension)

The need for improved agricultural extension throughout the developing world has never been greater. Agricultural and rural development and hence rural extension continue to be in a phase of transition in this part of the world. The vulnerability of farming in the developing world to climate change, to changes in natural resources quality (including desertification over large tracts), and lack of coping and adaptation strategies at micro and macro levels of decision making are all well documented, while globalization of commodity trade offers a mix of opportunities as well as challenges. The role of extension and support systems in this background is undergoing profound changes while no unified alternative framework has emerged (Eicher, 2007).

ICTs in the Context of Extension

Information and Communication Technology (ICT) is an umbrella term that includes computer hardware and software, digital broadcast and telecommunications technologies as well as digital information repositories online or offline (Selwyn, 2002), and includes contemporary social networking aspects, read / write interfaces on the web besides file sharing systems online. It represents a broad and continually evolving range of elements that further includes the television (TV), radio, mobile phones and the policies and laws that govern the widespread use of these media and devices. The term is often used here in its plural sense (ICTs) to mean a range of technologies instead of a single technology. From the perspective of agricultural knowledge and information systems (AKIs), ICTs can be seen as useful in improving linkages between the research and the extension sub systems. The experience of rural telecenters in the developing world shows that ICT can help in enabling rural development workers to gather, store, retrieve, adapt, localise and disseminate a broad range of information needed by rural families (Davison *et al* 2005). The ICTs in extension can lead to the emergence of knowledge workers that will result in the realisation of a bottom-up, demand-driven paradigm for technology generation, assessment, refinement and transfer (Meera, 2003; Meera *et al* 2004).

Conducive Environment for Effective Technology Transfer

For information and knowledge to be effectively used by rural communities several conditions should be met:

- ICT in agriculture sector plans
- Need for relevant agricultural information
- Timely information available in appropriate formats
- Institutional mechanisms and human capacity to link rural communities
- Rural access and exchange mechanisms: connectivity and telecentres

ICTs and Extension in the Context of Climate Change

The linkages between agriculture and climate are pronounced and often complex. Crops and livestock are sensitive to climate change in both positive and negative ways. Agricultural systems are most sensitive to extreme climatic events such as droughts, floods and hailstorms, and to seasonal variability and changing rainfall patterns. Against this backdrop, farmer adaptations are influenced by many factors, including agricultural policy, prices, technology research and development, and agricultural extension services (Kajfez-Bogataj, 2005). The poor often bear a disproportionate burden of direct damage from catastrophes and climate change as concluded by most studies in developing countries (IPCC, 2001). The role of inadequate institutional support is frequently cited in the literature as a hindrance to adaptation. For example, Adger and Kelly (1999) and Huq *et al* (1999) show how institutional constraints and deficiencies affected managerial capacities to cope with anticipated natural events. Many observers of rural development in recent times have commented on the frequent manifestations of unsatisfactory extension performance (e.g., Rivera *et al* 2001). Feder *et al* (2001) have suggested interrelated characteristics of extension systems in the developing world that jointly result in deficient performance, namely low staff morale, reduced efficiency and financial stress etc. One more such key factor is the number of clients and the vast spectrum of information / services needed to be covered by extension systems. Policy makers in the developing world have reacted to this with the deployment of more extension personnel which has continued the emphasis on a more centralized, hierarchical and top-down management systems. The requirement for combining a bottom up approach with the conventional extension process is yet to be fulfilled and the limitations on the extension process to influence issues such as credit availability, input supplies, market linkages and logistics facilitation continue without change. In effect, there has been no visible impact due to such changes within the extension system in many parts of the developing world. Sulaiman and Hall (2006) have described a range of extension initiatives from the public and private sectors that explain the way extension agenda is expanding as embodied in the concept of “extension plus” and have pleaded for new experiments in extension. Pluralistic institutional arrangements are emerging and are finding wider acceptance and this is mainly because developing countries have realized the need for extension to engage in a wider range of issues beyond merely disseminating production-oriented technologies. Extension pluralism is at the core of farmer adaptation strategies and ICT’s can offer new advantages in enabling reliable and rapid access to expert information support which is much needed in the realization of adaptation strategies on a large scale.

VASAT: Implications for Extension

The experiments on VASAT in field locations in India offer some clues for the development of new linkages between the research and extension sub systems. It is clear that new intermediaries in rural locations to support ongoing, conventional extension processes are needed in view of the near-impossibility of tackling the scale and demands for services required of extension personnel. The challenges of climate uncertainty require even faster response times than originally envisioned. The results emerging from the VASAT field studies show that when creatively deployed, ICT-based support systems can provide more in terms of quality information services that are accurate as well as timely. It is also possible to formulate newer linkages with different components of the extension system (as happened with distant extension workers responding to queries on the aAQUA site) provided the extension workers have access to online information systems however limited is the connectivity. The challenges addressed in the VASAT activities that have implications for extension practices are:

- Agricultural information support services offered with ICT infusion should be part of a wider range of general information services.
- Involvement of credible individuals from the locality as facilitators or intermediaries is essential to the sustenance of the information service as whole.
- Such facilitators need to have their capacities newly developed in the essentials of practical agriculture so that they are in a position to relate to extension personnel online or offline. The approach should be based on building science literacy.
- Methods derived from the open learning paradigm, especially those that ingrain the practices of teaching those with very limited class room exposure should be adapted in designing the capacity strengthening activities.
- Content needs to be aggregated by experts from different sources but it needs to be stored in granular format for rapid adaptation for local use.

- Vulnerability analysis with contemporary tools needs to be scaled sufficiently to a micro-level so that potentially affected people can apprise them and make use of them.
- Services availability in terms of input supply and testing need to be integrated with information and advisory services for greater impact.
- Strong linkages with national and local organizations responsible for extension and research are necessary for rural organizations to sustain their information services. Conversely, national and local extension organizations need to develop their capacity for online services management in order to make effective use of ICT-based channels that are increasingly becoming available with local and community-based organizations.

It is clear that further experiments on a much larger scale are necessary to assess the usefulness of ICT-mediated information services in supporting extension in general and in improving the coping strategies for coping with drought. It is also clear that expert-based and expert-derived information services can be easily aggregated into a digital knowledge organization that can combine different types of sources. For more effective extension support, new information delivery and exchange services covering both digital and non-digital channels need to be developed for reach as well as impact. ICRISAT has recently formed a consortium of state agricultural universities and India-based institutions of higher learning in ICT for developing such a knowledge organization in agriculture which proposes to build new linkages in the education-research-extension continuum. The activities of this consortium are expected involve at least 30000 farmers in three different regions of dry land India over a period of two years. The aim is to generate results on a scale that can be useful in building a model for the effective infusion of ICT-mediated services in support of extension that is oriented towards farmer adaptation. Capacity development and learning opportunities on a mass scale are viewed as the glue that will bind the new linkages over a long term.

Lessons learned and recommendations

The social and political environment within which ICT projects operate is crucial and supportive policies and measures are required. Awareness-raising, developing functional systems and capacities of stakeholders are processes that require time. A general lesson from initiatives that employ ICT for agricultural development is that successes are possible, but that programmes must be designed and implemented with care. Success is not derived automatically from inserting ICT into isolated, poor communities. In a 2006 survey, IICD analyzed the use of ICT in agriculture in over fifty supported projects. End users clearly indicated that awareness-raising and training are highly valued and lead to empowerment. Rapid impact in terms of increased income is registered in projects on price information and market access whereas more indirect impact was found in projects focusing on agricultural production, which is to be explained by the time needed to generate relevant content and integrate this into the production process. There is ample potential for effective use of ICT in agriculture and initiatives are promising. However, much still remains to be done. Several future trends of great importance are:

- Converging of media and tools for communication
- Increased web-based storage of agricultural information
- Cheaper and improved connectivity for rural communities
- Increased recognition by governments of the importance of the
- use of ICT in rural development
- Increased tailor-made, quality agricultural information services.

Information and Communication Technologies and Climate Change with reference to Multiple Use of Water

A. Abdul Haris
Senior Scientist (Agronomy)

Climate change is a concern for all of humanity. The Earth's climate is influenced by factors such as the amount of green house gases (GHG) in the atmosphere emitted by all sectors of the economy. Since 1970, the production of GHG has risen by more than 70 per cent causing changing weather patterns. Moreover, it is expected that the global effects of climate change, including deforestation could increase the likelihood of floods and droughts caused by severe atmospheric and oceanic disturbances, affecting human habitat and ecosystems. According to IPCC, global mean temperature increased upto 0.74 ^{0}C in the 20th century and is projected to increase by 1.1 to 6.4 ^{0}C for the 21st century. Agricultural productivity in Asia is likely to suffer severe losses because of high temperature, erratic rainfall leading to severe drought and floods. Ever increasing population, urbanization and industrialization is putting pressure on diversion of water to agriculture. Unpredictable precipitation patterns and increasing temperature may lead to water shortage, particularly in areas where water resources are already under stress from growing water demands. In developing countries like India, water shortages have been attributed to population growth, industrialisation, and unproductive water use, which are enhanced by changing climate. India will reach a state of water stress before 2025 when the availability falls below 1000 m^3 per capita (CWC, 2001). This has necessitated increased efforts in enhancing productivity of water to ease water scarcity and to provide food and nutritional security. Integration of different agricultural production systems to utilize water resources in a complementary manner is therefore required to harness synergy between them and to enhance the water productivity. Multiple uses of water provide challenging opportunities for increasing water productivity at various scales ranging from farm to basin scales under rainfed / dry land, irrigated and water logged areas. Using available water resources for more than one purpose or production system is inevitable to produce more food with less water by integrating crops, horticulture, forestry, fisheries, livestock, house-hold enterprises, domestic needs etc. With the changing climatic scenario leading to lower per capita availability of water in future, prudent use of available water resources and multiple use systems and recycling options are inevitable. Information and communication technologies (ICTs) include all technologies used in print and electronic media including remote communication. These technologies can contribute to combat climate change and its consequences by playing an important role in environmental protection, for instance, besides working to reduce its own emissions which are estimated to be around 2 to 2.5 per cent of the total of GHG emissions, could help indirectly to reduce GHG emissions belonging to other sectors, as well as, in climate monitoring, farming, helping to avoid further deforestation and setting up the necessary communications networks in the major emergencies and disasters around the world.

Climate change impact on soil and water resources

Modern agriculture is indirectly responsible for causing possibly irretrievable damage to the earth's natural resources, notably soil and water, and for polluting the environment through harmful greenhouse gas (GHG) emissions and contamination of water resources. The use of water will continue to increase as the population and economies of countries grow. This will likely put more strain on water resources and availability, and the chances of it getting exacerbated by climate change cannot be ruled out. The projected decrease in the winter precipitation over the Indian subcontinent would reduce the total seasonal precipitation during December, January and February implying lesser storage and greater water stress during the lean monsoon period. Intense rain occurring over fewer days, which implies increased frequency of floods during the monsoon, will also result in loss of the rainwater as direct runoff, resulting in reduced groundwater recharging potential. The latest findings of groundwater mining in the Indus-Ganga basin suggest that India's water use is already on the threshold of exceeding availability. The deep-well pump has also created an unforeseen problem. Highly intensive development of ground water usage in certain areas of the country has resulted in over exploitation leading to decline in the levels of ground water and sea water intrusion in coastal areas. The rapidly declining water level is attributed mainly due to uncontrolled urbanization and enhanced groundwater withdrawal and reduction in the available open space for recharge to groundwater. Rainfall failure occurs once every 3 to 5 years and is usually below 50% of the average annual rainfall of the region. During periods of rainfall failure, the groundwater level lowers since fluctuations in the water table levels depend on the rainfall when both surface and groundwater availability becomes critical. Drought begins to prevail and it is difficult to cope up with the water demand during this period. Similarly, in some locations or areas water shortage is observed just before the rainy season commences. The situation can be improved by adopting rainwater harvesting and artificial recharge to groundwater measures and also by adoption and systematic implementation of suitable soil and moisture conservation measures on small watershed basis. There are always strong links between soil conservation and water conservation measures. Reduction of surface runoff can be achieved by constructing suitable structures or by changes in land management. The artificial recharge to groundwater can be taken up by adopting different measures like rainwater harvesting at the level of individuals, at the level of colonies and by the institutions. Further, this reduction of surface runoff will increase infiltration and help in water conservation.

Climate change impact on Crops

Substantial decreases in cereal production potential in Asia may be faced by the end of this century as a consequence of climate change. However, regional differences in the response of wheat, maize and rice yields to projected climate change could likely be significant. The crop yields could likely increase up to 20% in East and South-East Asia while it could decrease up to 30% in Central and South Asia even if the direct positive physiological effects of CO_2 are taken into account based upon the crop yield projection using HADCM2. Crop simulation modelling studies based on future climate change scenarios indicate that substantial losses are likely in rainfed wheat in South and South-East Asia (Fischer et al., 2002). A 0.5°C rise in winter temperature would reduce wheat yield by 0.45 tonnes per hectare in India (Lal et al., 1998). A decrease of 2 to 5% in yield potential of wheat and maize for a temperature rise of 0.5 to 1.5°C in India is reported (Aggarwal, 2003). The potential for climate change–as expressed in changed precipitation regimes–to increase the risk of soil erosion, surface runoff, and related environmental consequences is clear. Timing of agricultural practices creates even greater vulnerabilities to soil erosion and runoff during certain seasons. Climate change and extreme events will undoubtedly alter soil microbial populations thus fertility and diversity. Multiple year droughts associated with high winds may create the conditions for possible severe wind erosion.

Information and Communication Technologies (ICTs)

ICTs refer to any electronic means of capturing, processing, storing and disseminating information. ICT is a combination of information technology (IT) and communication technology (CT). The former involves the processing and packaging of information, while the latter is concerned with the interaction, exchange and linkage with information and data bases between users via networking. The coverage of ICT goes beyond such activities as programming, networking and analyzing. New ICTs: Computers, satellites, wireless one-on-one communications (including mobile phones), the Internet, e-mail and multimedia generally fall into the New ICT category. The concepts behind these technologies are not particularly new, but the common and inexpensive use of them is what makes them new. Most of these, and virtually all new versions of them, are based on digital communications. Old ICTs: Radio, television, land-line telephones and telegraph fall into the Old ICT category. They have been in reasonably common use throughout much of the world for many decades. Traditionally, these technologies have used analog transmission techniques, although they too are migrating to the now less expensive digital form. A review of many academic studies shows that there are no simple and straightforward effects of ICT on society. Most effects are multiple and contradictory (Spears and Postmes 2000, Sharpe 2000; Wyatt and Henwood 2000; Rommes 2002). The ICT professions have constituted a privileged research area for understanding the relationships between skills and work organization.

ICTs Impact on Climate Change

Information and Communication Technologies (ICTs) are undoubtedly part of the cause of global warming as witnessed, for instance, by the millions of computer screens that are left switched on overnight in offices around the world. But ICTs can also be part of a solution, because of the role they play in monitoring, mitigating and adapting to it. ICTs can significantly help reduce climate change by promoting the development of more energy efficient devices, applications and networks, encouraging environmentally friendly design, reducing the carbon footprint in its own industry, ICTs promise to drastically reduce GHG emission, the creation of a standard methodology for calculating carbon footprint, the promotion of NGNs (reducing power consumption by up to 40%), promoting online vs. print publications.

ICT use in monitoring climate change

ITU work focuses on the use of ICTs (including radio and telecommunication technologies, standards and equipment) for weather and climate change monitoring, for instance in predicting, detecting and mitigating the effects of typhoons, thunderstorms, earthquakes, tsunamis, man-made disasters, etc. The WWW (World Weather Watch) is composed of three integrated core system components: The Global Observing System (GOS) provides observations of the atmosphere and the earth's surface (including the surface of the oceans) from all parts of the globe and from outer space .The GOS mainly acts as relay for remote sensing equipment placed on satellites, aircrafts, radiosondes (a type of weather probe), as well as meteorological radars on the earth and at sea. The Global Telecommunication System (GTS) combines radio and telecommunication equipment capable of providing real time exchange of a huge volume of meteorological data and related information between international and national meteorological and hydrological centers. The Global Data Processing System (GDPS), based on thousands of linked mini, micro and supercomputers, processes an enormous volume of meteorological observational data and generates meteorological products such as analysis, warnings and forecasts.

ICTs in forecasting and broadcasting weather information

Weather forecasting is the application of science and technology to predict the state of the atmosphere for a future time and a given location. Weather forecasts are made by collecting quantitative data about the current state of the atmosphere and communicating this data to the target stations for forecasting the weather. Human input is still required to pick the best possible forecast model to base the forecast upon, which involves pattern recognition skills, teleconnections, knowledge of model performance, and knowledge of model biases. The chaotic nature of the atmosphere, the massive computational power required to solve the equations that describe the atmosphere, error involved in measuring the initial conditions, and an incomplete understanding of atmospheric processes mean that forecasts become less accurate as the difference in current time and the time for which the forecast is being made (the *range* of the forecast) increases. The use of ensembles and model consensus help narrow the error and pick the most likely outcome. There are a variety of end uses to weather forecasts. Weather warnings are important forecasts because they are used to protect life and property. Forecasts based on temperature and precipitation are important to agriculture, and therefore to traders within commodity markets. India Meteorological Department (IMD) started weather services for farmers in the year 1945. All India Radio in the form of Farmer's Weather Bulletin (FWB) broadcast it. IMD launched Integrated Agromet Service in the country for 2007 in collaboration with different organisations/institutes. Presently bulletins are being issued from three levels viz. National Agromet Advisory Bulletin,State Agromet Advisory Bulletin and District Agromet Advisory Bulletin. These weather-based advisories are disseminated to the farmers through mass media dissemination, Internet etc as well as through district level intermediaries.

Role of Weather Information in Farm Management

Mass media dissemination agencies such as Radio, television, print media etc. and village level knowledge dissemination agencies are playing an active role. This information help farmers for cultivars selection, choosing windows for sowing/harvesting operations, Irrigation scheduling– optimal water use, mitigation from adverse weather events such as frost, low temperature, heavy rainfall – at critical crop stages, Fertilizer application, Pesticide/fungicide spraying schedules ,Feed, Health and Shelter Management for Livestock. The use of ICTs in the enhancement of various forms of Household livelihood assets including social capitals following de satge et al. (2002) are highlighted as:

- Natural Capital; opportunities for accessing national government policies.
- Financial Capital; communication with lending organizations, e.g. for micro-credit.
- Human Capital; increased knowledge of new skills through distance learning and Processes required for certification.
- Social capital; cultivating contacts beyond the immediate community.
- Physical capital; lobbying for the provision of basic infrastructure.

Multiple water use systems and practices

The term multiple-use of water is increasingly used in the water sector and the concept of multiple-use services (MUS) has emerged as an alternative approach to providing water services aiming to meet people's multiple water needs in an integrated manner. Multiple uses of water can be defined as the practice of using water from the same natural or manmade system or infrastructure for multiple uses and functions. In essence, a multiple use approach involves (1) assessing the range of water needs in collaboration with end users, (2) examining the water sources available - from rainwater to wastewater to piped systems, and (3) matching water supplies to needs based on the quantity, quality and reliability required for various purposes. Multiple-use services (MUS) is the conceptual approach of providing water services provision for multiple uses, incorporates also the roles and functions of water related systems for local communities. As defined by many researchers (Van Koppen et al. , 2006) Multiple-use Water Services (MUS) is a participatory, integrated and poverty-reduction focused approach in poor rural and peri-urban areas, which takes people's multiple water needs as a starting point for providing integrated services, moving beyond the conventional sectoral barriers of the domestic and productive sectors. The Multiple uses of water i.e. using the available water sources for more than one uses/production system is inevitable to produce more with less water. Multiple use systems, operated for domestic use, crop production, aquaculture, agro forestry and livestock, can improve water productivity and reduce poverty. However, intensification of multiple use of water in the catchment may affect downstream flow both in terms of quality and quantity. There is a need for proper understanding and economic evaluation of non-irrigation uses (Meinzen-Dick and van der Hoek, 2001) and to greater recognition of the linkages between water management activities and aquatic ecosystems (Bakker and Matsuno, 2001). It is well recognized that people uses water for multiple purposes. This multiple use happens at different levels: the household level, the water system level, and the catchment or basin scales. For example, in many rural and urban areas, domestic water supply networks are used for small-scale productive activities. Similarly, irrigation schemes not only supplies water for irrigating field crops, but are also used for livestock or backyard irrigation as well. The aquatic systems such as wetlands including rice-based systems provide many critical productive and ecosystem services like recharging groundwater, flushing contaminants, and supporting wildlife. Thus, multiple use systems can provide the more vulnerable users with low cost services for domestic water, water for agriculture, home gardens, livestock, habitats for fish and other aquatic resources and rural micro-enterprises such as brick-making. In order to derive maximum benefit from the depleted or diverted water and maximize output to increase water productivity, the productive or beneficial interventions of multiple nature of both non-consumptive and less water consumptive such as fisheries, aquatic crops, aquatic resources, livestock etc. may be integrated into the existing irrigation and water use systems/water infrastructures. However, an improved understanding of competition and complementarily of all water demands is essential for effective multiple use management (Li et al. 2005).

Multiple uses of agriculture water management systems

Multifunctionality of agriculture water management systems has been receiving increased recognition. In East Asian countries, multifunctionality of rice irrigation systems has become a focal issue in agricultural policy in the context of the international trade negotiations. The pre-symposium on Multifunctionality Roles of Paddy Field Irrigation in the Asia Monsoon Region for the Third World Water Forum, Japan March 2002 provide a first panorama view on this issue. For the systems in Asia countries, especially rice irrigation systems in Monsoon Asia, it can be summarized below in terms of three broad categories: (1) livelihood and Economic functions, (2) Hydrological cycle and ecosystem functions, (3) Social and cultural functions.

Livelihood and economic functions

While irrigating rice and diversified crops, orchards and fodders, agriculture water management systems also provide water for a vide range of livelihood and economic purposes, including:

1) Farmhouse water supply, In remote, mountainous rural and pasture areas, where specific domestic water supply is not established yet, agriculture water management systems, either surface water system or groundwater system or rainwater harvesting systems, are the sole source of water supply for a large number of rural communities, covering drinking, laundering, bathing, sanitation, livestock, home industry and home gardens, etc., almost all aspect of rural livelihood.

2) Aquaculture, Fish living in the paddies eat rice pests (algae and insects), while producing nutrients for the rice, and protein (or cash) for the farm family. Ducks have a similar function and produce enough meat to compensate for any fish that they might eat as well. Rice-fish-duck culture can increase rice production while providing farmers with improved nutrition, extra income, and reduced application of fertilizers and pesticides.

3)Rural enterprises, in most rural communities where domestic water supply networks are not established or completed, agriculture water management system still service as the major water supplier to rural enterprises, such as agro processing, small manufacturing, shops and restaurants.

4) Domestic water supply, while small traditional agriculture water management systems provide water supply to rural livelihood, medium and large scale irrigation systems normally provide water allocation to domestic and industrial water use for townships and even medium and large cities. In China, large irrigation schemes provide 25.8 billion m3 of water to domestic and industrial users each year, accounting for 15% of national domestic and industry water supply amount, benefiting 200 million populations.

5) Hydropower generation and navigation, many large multifunctional agriculture water management systems include hydropower general components either at the reservoirs or even at the main canals of irrigation schemes. Navigation is another important function of some agriculture water management systems such as in Cambodia.

Hydrological cycle and ecosystem functions

Many of the agriculture water management systems provide important hydrological cycle and ecosystem functions in rural watersheds, such as flood prevention, groundwater recharge, prevention of soil erosion and landslides, water and air purification, conservation of biodiversity, etc.

1) Flood Control and prevention of soil erosion and landslides. Water cycling systems comprise of reservoirs, ponds, canals, fields bunds, ditches, drains and platforms of paddy fields can hold surface runoff during the rain season. In highland areas, they can prevent soil erosion and landslide, lower the peak flow of rivers, while in lowland areas they act as buffers and increase the water storage capacity of basins.

2) Groundwater recharge. This is an important hydrologic feature of rice irrigation. In Kumamoto area of Japan, 85% of all groundwater recharge is accounted for from paddy fields. Several other studies also showed the importance of rice irrigation systems for regional groundwater recharge. The magnitude of recharge depends on soil texture, soil structure, thickness of the layer, soil and water temperature, ponding depth, groundwater level and topographic features.

3) Water purification. The quality of the water leaving the paddy fields may be improved as a result of the adsorptive capacity of the soil to hold contaminants such as heavy metals, and its ability to transform organic contaminants. Paddy fields behave as artificial wetlands as their capacity to remove nitrogen and phosphorus. Ponding condition of paddy fields causes an increase in denitrification .

4) Conservation of Biodiversity. Rice fields, together with their contiguous aquatic habitats and dry land comprise a rich mosaic of rapidly changing ecotones, harboring a rich biological diversity, maintained by rapid colonization as well as by rapid reproduction and growth of organisms. In Fukuoka prefecture of Japan, 30% of rare species live in the paddy environment. These habitats have importance for ecosystem health and biodiversity both locally and for the global ecosystem through migratory birds (e.g., cranes) and insects.

5) Climate adjustment. Evapotranspiration from paddy fields takes a significant amount of heat that results in reducing ambient temperature of the surrounding area in the summer. In winter, paddy fields may cause an increase in the temperature. This function has been recognized in periurban areas where paddy and urban land are scattered. The temperature effect is higher where the paddy area is larger and is applicable.

Social and cultural functions

Throughout the rice producing regions of Southeast Asia, the integration of paddy cultivation and local cultures has been evolving for thousands of years. Religious rituals and cultural identity are tied to the rice cycle. In general, people agree that rice irrigation systems have following social and culture functions.

1) Community empowerment. Traditionally, small-scale paddy-based irrigation systems were built and managed by the farmers themselves. With the trends of decentralization and participatory governance, more agriculture water systems are managed by farmers cooperatively. Experiences derived from various water users' associations are applying to broad-based rural development.

2) Cultural Heritage. Irrigated paddy cultivation is a living heritage, which refers to tradition and reaffirms that heritage in the present. The significant components of that heritage may include the visual landscape, the architecture of rural buildings, the irregular bunds marking the borders of the paddy fields, the irrigation channels, and the fields themselves; as well as spiritual tradition in sharing and conserving nature resources. Balinese culture cannot be separated from the subaks. The basic philosophy of life for Balinese people (Tri Hita Karana) emphasizes the importance of maintaining harmony in the world. Subak rituals play an important role in developing awareness among farmers that water as a gift from God should be used fairly for the benefits of all.

3) Ecotourism and recreation value. Paddy fields combined with water systems and traditional farm houses present a live picture, spacious, tranquil, verdant and aroma. The combination of cultural and aesthetic values is appreciated by many people. In industrialized countries, such as Japan and Republic of Korea, urban dwellers are willing to travel to paddy fields for sightseeing and recreation. In Bali, paddy fields are light spots of local ecotourism.

3. Constrains in fully recognizing multifunctionalities

Despite a increasing recognition recent gained in developed countries and relevant international organizations, mutifunctionality of agriculture water management systems is still far from been fully understood, widely recognized and formally adopted into policy innovation due to some major constrains. In Southeast Asia, except for some large and medium scale multi-purpose water projects which was consciously designed and constructed for multiple functions and are receiving diversified financial supports, most agriculture water management systems, especially traditional small rice irrigation systems are primarily designed and constructed for rice cultivation which are financed solely by farming. Mutifunctionality of these irrigation systems occurred unconsciously due to the nature characteristics of hydrological cycle. People are used to enjoy the multiple services which agriculture water management systems brought to them, not aware of that in modern economic system, cost-benefit of water resources use for these multiple functions needs to be reviewed and justified from the prospective of integrated river basin water resources management. Some of the systems developed at ICAR-RCER and popular with the farmers are (i) Integrating agriculture and aquaculture with secondary reservoir in rainfed areas as well as in canal commands (ii) Rice-Fish culture in low land rice wheat system (iii) Trenches and bed system for fishery and horticulture, (iv) Makhana, fish and horticultural system etc. Secondary reservoir can be prepared by excavating soil to a desirable depth, to harvest run off rain water, store excess flows from canal or small rivers etc. The excavated soil is spread around the periphery to form a bund with crest level at least 50 cm above the highest water level to ensure that water do not overtop the bunds. High value horticultural/vegetable production on bunds utilizing seepage water with little supplemental water can produce good profit from the land, which was otherwise poorly utilized. In conjunction, good fish production can be achieved with water quality management through water routing for irrigation purpose. The routed water containing good amount of nutrients provide opportunity for applying water to the fields in correct amount and at appropriate time, which enhances yield and quality of agricultural produce. Ducks, poultry, piggery, etc. are other components that can be added to have complementary benefits. Trenches and bed system is recommended in deep waterlogged areas or backwater areas by making alternate strips of trenches and beds by excavation. Water collected in the trenches can be used for fisheries and duckery etc and beds can be used for planting vegetables and horticultural crops. The system improves both land and water productivity. Rice-fish culture is practiced in lowlands and shallow waterlogged areas of eastern India to improve productivity. ICAR-RCER, has recommended creation of a shallow central refuge occupying approximately 10 % area due to which fish may get extended growth period during succeeding wheat crop after rice, thus increasing fish yield.

Summary and Conclusion

According to IPCC, global mean temperature increased upto 0.74 ^{0}C in the 20th century and is projected to increase by 6.4 ^{0}C for the 21st century. Agricultural productivity in Asia is likely to suffer severe losses because of high temperature, erratic rainfall leading to severe drought and floods. Substantial decreases in cereal production potential in Asia may be faced by the end of this century as a consequence of climate change. The science of climate change which has developed over the last century or so, has benefited greatly from the parallel development of ICTs. ICTs enable the usage of computers and related tools to enhance the quality of products, labour productivity, international competitiveness and quality of life. ICTs are used as a critical resource in the promotion of socio-economic development, with a potency to alleviate poverty. The integration between the management software and the Internet sites has a number of features to facilitate the relationship between farmers and the research institutes. Farmers can, for example, use the site to obtain information about the water stored in the dam. There is also more specific information available, which can only be accessed by farmers registered in the system. Data such as the water applied in each field, or the volume per hectare spent on a particular crop, are calculated by the management software and made available to farmers on the Internet site. More importantly, all this information is updated on a daily basis, so that farmers can follow the pattern of water use in each particular field or crop throughout the irrigated season. Unpredictable precipitation patterns and increasing temperature may lead to water shortage, particularly in areas where water resources are already under stress from growing water demands. With the changing climatic scenario leading to lower per capita availability of water in future, prudent use of available water resources and multiple use systems and recycling options are inevitable. Multi-functional impacts of agriculture water management systems vary in regions, depending on the climate, social, cultural and economic conditions in addition to settings of the infrastructure and management system. The productive utilization of available water resources is instrumental in increasing local community resilience and risk management that may result from climatic uncertainty. Information and communication technologies will play a greater role in dissemination of multiple water use practices in the light of climate change scenario leading to decreased per capita water availability. Communication technologies can facilitate networking among institutions, scientists and practitioners of MUS creating synergies at regional and global level.

REFERENCES

Aggarwal, P.K., 2003: Impact of climate change on Indian agriculture. Journal of Plant Biology, 30, 189-198.

Bakker M., Matsuno Y., 2001. A framework for valuing ecological services of irrigation water. *Irrigation and Drainage Systems*, vol. 15, pp. 99-115.

CWC (Central Water Commission), 2001: Water and related statistics. Report of the Ministry of Water Resources, New Delhi.

de Satge, R Hollway, A Mullins, D Nchabaleng, L and Ward, P (2002). Learning about livelihoods. Insights from Southern Africa. Peri peri and Oxfam.

Fischer, G., M. Shah and H. vanVelthuizen, 2002: Climate change and agricultural vulnerability. Preprints, *World Summit on Sustainable Development*, Johannesburg, 160 pp.

IPCC. 2007. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, [M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (eds.)]. Cambridge University Press, Cambridge, UK and USA, 976 pp.

Lal,M., K.K. Singh, L.S. Rathore, G. Srinivasan and S.A. Saseendran, 1998:Vulnerability of rice and wheat yields in NW - India to future changes in climate. *Agri. & Forest Meteorol.*, **89**, 101-114.

LI Q., Gowing J. W., Mayilswami C., 2005. Multiple use management in a large irrigation system : an assessment of technical constraints to integrating aquaculture within irrigation canals. *Irrigation and Drainage,*vol. 54, pp. 31-42.

Meinzin-Dick R., van der Hoek W., 2001. Multiple uses of water in irrigated areas. *Irrigation and Drainage Systems*, vol. 15, pp. 93-98.

Rommes, E., (2002). Gender Scripts and the Internet. Philosophy and Social Sciences. Enschede: Twente University, p. 300.

Sharpe, M., (2000). IST 2000: Realising an Information Society for all. Brussels: European Commission, p. 150.

SIKKA A. K., BHATNAGAR P. R., HARIS A. A., KAUSHAL D. K., PRASAD L. K., DEY A., REDDY A. R., KUMAR U., 2010. *Productive utilisation of waterlogged areas through multiple use system in eastern India.* Research Bulletin R-24/PAT-14, Patna, India, ICAR Research Complex for Eastern Region.

Spears, R.; and T. Postmes, T. (2000). Social Psychological Influence of ICT's on Society and their Policy Implications. Amsterdam: Infodrome, p. 80.

Van Koppen B., Moriarty P., Boelee E., 2006. *Multiple use water services to advance the millennium goals.* Research Report 98, Colombo, International Water Management Institute.

Wyatt, S.;and Henwood, F. (2000). Technology and Inequality. London: Routledge.

Y. Matsuno and H. S. Ko and C. H. Tan and R. Barker and G. Levine, 2002, Accounting of agriculture and nonagricultural impacts of irrigation and drainage systems, Working paper 43, IWMI, Colombo, Sri Lanka

Role of ICT in Integrated Rodent Pest Management

Dr Mohd. Idris
Sr. Scientist (Agril. Entomology)

Rodents are a real threat to the agriculture and human & domestic health. In the quest of more agriculture production to feed the ever growing population, newer technologies are being adopted by the farming community that caused imbalance in natural and ecological conditions. Moreover, intensive agriculture creates conducive environment to the pest and diseases. Rodents are highly evolved mammal and adaptive to all type of ecological conditions. Adaptability enables them to fight against management strategies applied by the researchers to control them. Therefore, no single method of rodent control is applicable to all pest situations. Since the religious taboos that prevalent through out the country in one form or other, are the major constraints in our society which hinder even initiation of rodent management programme. It needs to develop awareness among religious minded people about noxious activities of the rodents in agriculture, house hold commodities and health of human being and domestic animals, would be helpful to change the attitude of the people. It needs to educate people through following means ICT tools.

Audio-visual aid:

Still in rural area radio is the main source of entertainment as well as collect information of newer technologies generated by the researchers in the field of agriculture. Though, the things which are heard can hardly be retained in the memory for a long time. Therefore, television assumes greater importance to percolate information to the end users. Out of 5 senses, at least two viz., vision and hearing are covered by television. Through these audio-visual aids, noxious activities like damage of various crops and household commodities, and damage caused by them in urban situations may screened that will generate bad thinking among masses about the perilous creature-Rodents . It will develop awareness in community and people will try to eliminate these tiny mammals from their surroundings. Thereafter, management programme should be broadcasted on radios and screened on television. Even the farmers who have adopted or practiced management technology and have benefited may be invited to the studios and their experiences may be shared by all.

Tele-communication:

Nowadays, basic and mobile phones are basic necessities of urban and rural people. Since rodent pest management technologies are easy to operate and quick to translated into practice on farmer's fields. By means of ICT tools like basic and mobile phones, the selected farmers may be contacted and informed about rodent management programme and venue in the area. In this way large number of farmers could be assembled at one place and also enable to disseminate technology to end user. Generally following training programmes are being organized for dissemination of technology to the end user.

A) Apex level training programme: This training programme is to be imparted to the Directors of Agriculture. Emphasis may be on management and transfer of technology, the type of training required for lower strata, man-management, molding the attitude and behavior of the people towards rodent control etc. Besides these, inter-personnel and organizational problems in translating the technology need to be resolved. This training will also ensure the procurement of good quality rodenticides, baits etc. Some areas like government lands common property resources, railway tracks, road sides are act as breeding ground of the rodents, should be given proper attention on priority basis for management activities.

B) **Middle level training programme**: In this training programme, knowledgeable personals from ICAR institutions and agricultural universities are trained. Training may be conducted for a week and refresher courses should be conducted once in two years period.

C) Field level training programme: This training is to be imparted to the Subject Matter Specialist (SMS) and farmers etc. may invariably include a package of rodent management technology. In this programme, ICT tools may play a very effective role because rodent management is skill oriented training, therefore, more emphasis to be laid on practical i.e. identification and estimation of live burrows, preparation baits , laying of poison bait etc.

D) Farmers training programme: To impart this training among the framers, some organizations like Nehru Yuvak Kendras, Farmer's club, Yuvak Dals and Mahila Mandals are playing a significant role in the society. Rodent squads should be formed within the organizations and vigorous training on rodent pest management techniques may be given to the squads by using various ICT tools like computer, internet television etc. When these squads are fully trained, the media may be utilized to popularize the rodent control campaigns on community basis. Through modern ICT tools, above mentioned training programme could be organized in large scale by using less effort and possible to disseminate rodent pest management technology to the end user.

Use of ICT to support pest management:

The main ICT tools used in transfer of technologies among farmers, extension workers, pest management agencies, and plant protection officials are computer, the internet and digital media. Internet could be used to support decision making by Integrated Pest Management Farmers as well as activities. Now, the government and other organizations that have started initiation to develop farmer's friendly and comprehensive ICT tools. To utilize ICT facilities effectively and efficiently, perhaps we will have to wait for the next generation of farmers who will have used computer in school, to discover what they want to do with the internet or whatever comes after it. Some of the Following significant steps are in pest management technology that may be used to search websites which provide IPM related information. These steps are:

1) Websites with identification guides and pest fact sheets provide information on ***Identification of pest species, its damage and life history***.
2) Websites with market news and agriculture statistics provide information on ***Economic injury thresholds.***
3) For getting information on ***Monitoring, scouting and predicting populations***, search the websites which provide real time pest maps or modeling software or weather information.
4) Websites with data bases of chemicals and guides to natural enemies provide information on ***selecting and applying control techniques***.

With the help of ICT tools, farmers can obtain scientific knowledge or technologies about pest problems. IPM workers could disseminate knowledge to the end user effectively with better way and would go long way towards improving agricultural development. However, much needs to be done for mainstreaming powerful extension ICT tools like radio, television, internet and digital media such as compact disk etc. in agriculture extension system, so as to secure food security and address the development challenges of malnutrition and hunger, besides many others by controlling various crop pests which stole 15-20% agricultural produce. Todays need is to develop comprehensive national communication and media strategies to encourage public private partnership in community broadcasting, including licensing and subsidies for information services like FM station, local TV channels, internet providers and other means of ICT tool.

Role of communication and information technology in improvement of soil quality in changing climatic situation

Dr. Chunchun Kumar
Senior Scientist (Soil Science)

The major structural change in agriculture during the past four decades have been mainly directed towards meeting the demands of the growing population, especially in the under developed and developing countries like India. In this process, agriculture became less organic in its technological and practical aspects as high input use played a key role in augmenting food production. Presently, agriculture is at cross roads with higher production envisaged to meet the growing demand for food commodities and emphasis on consuming the natural resources in order to keep the earth green and healthy. As per Kisan Ayog, Bihar, during 1983 per capita cereal consumption per month used to be 15.8 kg. which became 13.0 kg during year 2005. Further, they have also forecasted the cereal consumption to go as low as 12.0 kg per capita per month by the year 2012. More and more consumers want to know what they are eating and whether the products are safe to consume. There is an increasing appreciation about the quality of food as well as the extent to which the environment is affected by excessive and indiscriminate application of chemicals. Therefore, organic farming is attracting greater attention worldwide. The various factors for successful adoption of organic agriculture in selected areas where they have competitive advantage may be analyzed, and research for generating technologies that support modern organic farming may be strengthened. Such research may not only contribute to enhanced nutritional and environmental security but also improve export prospects in the country.

The second green revolution could be termed as knowledge revolution and there are already some visible signs that Asia-Pacific rural Agriculture is in midst of it. The new information and communication technologies (ICTs) are bringing about and sustaining this revolution by empowering the poor farmers with up-to date knowledge and information. ICT is an umbrella that includes the communication devices such as radio, television, cellular phones, computer and network hardware and software, satellite systems and so on. These days reading daily news paper has become regular habit of rural farmers apart from hearing radio and watch in TV, which are very strong source of communication. Many people may not be knowing that deficiency of copper in food may lead to enhancing the cholesterol level in their blood which may cause heart disease. Such informations are being known to the people through newspaper/ radio/TV etc. Some of the significant advantages of ICT are timely information on weather forecasts and calamities, better and spontaneous sustainable agricultural practices, better marketing exposure and pricing, reduction of agricultural risks and enhanced incomes, better awareness and information, improved networking and communication, facility of online trading and e-commerce, better representation at various forums, authorities and platform, etc.

Now, very sustainability of agriculture has become a big challenge because we have caused serious damage to our natural resources. Next to water, nutrients are an important input for guiding sustainable growth of agriculture. The N:P:K use in Punjab is 35:9.4:1 while in Haryana and Bihar it is 75:24:1 and 29:5:1 respectively as against recommended level of 4:2:1. The combined use of different sources of plant nutrients i.e. organic, biological and inorganic amendments is important for the maintenance and improvement of soil fertility and plant nutrient supply at an optimum level for desired crop productivity. Unbalanced use of N:P:K have caused deleterious long term effects on soil fertility. In areas subjected to intensive cultivation, application of mere chemicals is not sufficient for sustaining the yields, and it also leads to deficiency in the soil of secondary nutrients and micronutrients which limit crop productivity. Use of organic manure, crop residue and biodegradable rural and urban waste not only supplement the chemical fertilizers but also increase the efficiency in nutrient supply, leading to improvement of physical and biological properties of the soil.

Component Input level Fertilizer equivalent of input in terms on crop yield

Organic manure (FYM) per tonne 3.6 kg N+P2O5+K2O(2:1:1), Green manure (Sesbania) per tonne 4.4 kg N, Green manure (Sesbania) 45 days crop 50-60 kg N for HYV rice, Cowpea intercropped with castor Legume buried 30 kg fertilizer N on castor after 6 weeks, Leucaenia lopping 88 kg N in Leucaenia-25 kg fertilizer N on sorghum, Rhizobium Inoculants 19-22 kg N, Azotobacter and Azospirillum Inoculants 20 kg N, Blue Green Algae 10 kg/ha 20-30 kg N, Azolla 6-12t/ha 3-4 kg N/t, Sugarcane trash 5 t/ha 12 kg N/t and Rice straw + Water hyacinth 5 t/ha 20 kg N/t. The IPNMS helps to restore and sustain soil fertility and crop productivity. It may also help to check the emerging deficiency of nutrients other than NPK. It brings economy and efficiency in fertilizer use and favorably affects the physical, chemical and biological environment of soil. It helps to produce fruits of high nutritional quality in sufficient quantity. The future production scenario, judicious use of chemical fertilizers in combination with organic source of nutrients may play an important role in improving soil health and also help to sustain optimum production of good quality fruits. In country like India to meet out the ever increasing demand of large population for food, we must go for organic farming. But use of organic and inorganic i.e. Integrated Nutrient Management is only the alternative to fulfill the target. It calls for a long term dedication and commitment, both from those who till the land and from those who conduct research and educational programmes to improve and sustain agriculture. Sustainable or regenerative, agriculture will always have to confront the urgencies of time as it also faces the question of how to help feed people profitably. Organic agriculture is often associated with low yields, therefore it is essential to establish certification scheme to facilitate exports of products and accreditation agency to certify the produce of the farm. Farmers experience some loss in yields during conversion period (3-5 years) depending on situation. Dry lands are potential place. Medicinal and aromatic plants are first crops for organic farming. It is not possible to meet nutrient requirement of crops entirely from organic sources in India but approximate potential of NPK (15 to 18 m tonnes) is equal to our chemical fertilizer. However, there is significant environmental benefits of organic farming and the food produced by such land certified as pesticide free are considered as superior in quality as compared to the one produced by using balanced nutrient system. Since organic farm uses several farm grown inputs, and less dependent on market purchased inputs, it is economically attractive to the growers. A case study showed for rice (a) Rs. 11, 250-cost of cultivation when chemicals were used while (b) Rs. 10, 590 when biofertilizer and organic (neem cake etc. used). The output input ratio in modern farming is 3.76 while 4.95 in organic farming.

Agencies accredited by the government:

Ecocert (Germany)

SKAL(The Netherlands)

IMO (Switzerland)

Indocert (Cochin)

APOF (Bangalore)

ISCOP (Coimbatore)

IRFT (Mumbai)

Websites on organic farming (import-export):

www.agr.ca

www.allorganiclinks.com

www.fas.usda.gov./info/agexporter.com

www.foodcontact.com

www.gepa.org.go

www.indiamart.com

www.intracem.org/mds/sectors/organics

www.linksorganic.com

www.newscientist.com

www.nre.vicgov.av

www.ocia.org

www.organicpathways.co.nr

www.organicnewzealand.org

www.webfoododors.com

The available information on organic farming and specially those concerning the sustainable system is very meager and some of the research undertaken during the era before the use of chemical fertilizers and pesticides has relevance to today's organic farming. Moreover, we must realize that the future progress of the organic farming systems will largely depend on generation of new technology suitable to a particular agro climatic condition under the present structural set up. The development of sustainable farming systems will require interdisciplinary approach to research on resource conservation, reduced tillage, pest management, crop rotations, improved crop varieties etc. ICTs can also be used for promoting organic farming and sustainable agriculture. The extension functionaries at different levels shall also need to be attuned to the change in farming concept i.e., from energy intensive agriculture to organic agriculture. The scientific literature of organic farming and the character and status of educational materials related to organic farming require inventory, analysis and assessment of the existing reports and professional publications, extension materials, and other sources of information with regard to their relevance and applicability to the informational and educational needs of contemporary organic farmers. High level of illiteracy in most rural areas of the region would require broad band connectivity for audio and visual information exchange. Without this, useful and relevant information content will not be generated and disseminated to the rural population. Telecommunication can play a vital role. With cellular telephony and the internet connectivity individuals and households and connecting communities. Kiosks, tele-centres, public call offices and internet cafes and low cost computers and hand held devices are being experimented in India (About 5 lakh villages have been connected by year 2008). This article describes the role of remote sensing and Geographical Information System (GIS) technologies for mapping and characterizing soils at various scales. The spectral behaviour of soil and its components, which is fundamental to deriving information from remote sensing data, is also discussed. Furthermore, the scope of present day remote sensing data for varying levels in- formation generation is also reviewed. The aim of this article is also to suggest measures for the implementation of these information and communication technology in the country with a greater emphasis on the systematic approach towards precision farming operationalisation.

Precision farming employs a systems engineering approach to crop production where inputs are applied on “as needed basis;” and is achievable by recent innovations in information technology such as microcomputers, geographic information systems (GIS), positioning technologies (Global Positioning System), and automatic control of farm machinery. It is a holistic approach to micromanage spatial and temporal variability in agricultural landscape based on integrated soil, plant, information, and engineering management technologies as well as economics. The All India Soil Survey scheme was initiated in 1956 at the Indian Agricultural Research Institute (IARI) with four regional centres located at Delhi, Calcutta, Nagpur and Bangalore to carry out reconnaissance soil survey, correlate and classify soils and prepare small scale soil maps. During 1969, the All India Soil and Land use Survey Organization was bifurcated on the basis of developmental and research work. A new organization “National Bureau of Soil Survey and Land use Planning” was established in Nagpur. The establishment of Indian Photo interpretation Institute (IPI, now Indian Institute of Remote Sensing) in 1966 provided the training support to various soil surveyors on the use of aerial photographs. The initial soil surveys were based on either ground methods or through on a systematic aerial photo interpretation approach. A number of studies on soil survey were carried out by various workers in India in different regions using aerial photographs. Use of satellite remote sensing for soil survey and mapping received appreciation during early 1980s in India, and based on the potential of remote sensing techniques it was decided to map all the States and Union Territories of India on 1:250,000 scale following a multiphase approach consisting of image interpretation, field survey, soil analysis, classification, cartography and printing (Velayutham 1999). The use of digital image processing for soil survey and mapping was initiated with the establishment of National Remote Sensing Agency and Regional Remote Sensing Service Centres.

Development of satellite remote sensing for soil studies

Before the launch of Landsat-1 (in 1972), aerial photographs were being used as a remote sensing tool for soil mapping, and, exhibited their potential in analyzing physiography, land use and erosion status. Subsequently, 1972 onwards satellite data in both digital and analog have been utilized for preparing small scale soil resource maps showing soil sub-groups and their association. The high resolution Landsat TM and Indian Remote Sensing Satellite (IRS) LISS II data which became available during mid eighties, enabled soil scientists to map soils at 1:50,000 scale, which is used for district level planning. At this scale soils could be delineated at association of soil series/family level. The SPOT and IRS -PAN data offered stereo capability, which has improved the soil mapping efforts. Indian Remote Sensing satellites (IRS-1A, 1B, 1C and 1D) provide state-of-the-art database for natural resources inventories. Prior operational work in Remote Sensing with respect to agriculture has been undertaken by the space community which has been summarized by the following table 1.

Table1. Major Indian Remote Sensing Missions for Agriculture (source: Map India Conference 2003)

Mission	Year of launch	Sensors
IRS 1-A, 1-B	1988 1991	LISS-1(72.5resolution;148km Swath), LISS-11(36.25m resolution;142km swath)
IRS P2	1994	LISS III(36m resolution;142km swath
IRS IC,ID	1995 1997	PAN (5.8m resolution ;70m swath(LISS- 11(23.5m;70.5m resolution; 141km ,148km swath) WiFS (188.3m resolution 774m swath)
IRS P3	1996	WiFS (188.3 m resolution; 774km swath)
TES	2001	PAN(1m resolution; 14km swath)
RESOURCESAT-1	2001	LISS-IV(6resolution;25km swath)A WiFS (80m resolution;800km swath)
CARTOSAT-1 (IRS-P5)	2002	PANStereo(2.5 km resolution;30km swath)
CARTOSAT-2	2003	PAN Stereo (1km resolution; 12km swath)

Spectral behavior of soils

Spectral response pattern of soil is generally governed by a number of factors. The properties of soils that govern their spectral reflectance are colour, texture, structure, mineralogy, organic matter, free carbonates, salinity, moisture and the oxides/ hydroxides of iron and manganese. Chemical compositions of the soil influences spectral signature of soils through the absorption processes. In near infrared (NIR) and middle infrared (MIR) domain, absorption feature of soil components in solid phase originate primarily from the vibrations of bounded nuclei. Soil texture refers to relative proportion of sand, Silt & clay and affects the spectral reflectance of the soils due to its influence on water holding capacity and the size of soil particles. Finer the particles size, the soil surface becomes smoother and more incoming solar energy is reflected. An increase in particle size causes a decrease in reflectance. However, silt content of soil is considered as major controlling factor for spectral reflectance. The reflectance becomes lower as the silt content decreases (Hoffer 1978). However, it is commonly observed that sandy soil exhibits higher reflectance than that of clayey soil, which is due to abundance of macro pores and air-soil interface that cause multiple reflection/ scattering.

Soil erosion, an important soil degradation process can influence soil spectra. Soil erosion influences indirectly by influencing soil surface roughness and iron content in top soils. So the more is the erosion the more will be soil reflectance (Latz et al. 1984) in the longer wave length of visible and NIR region. Technology of remote sensing is advancing. Narrow band imaging spectroscopy in optical and thermal region of electromagnetic spectrum will provide comprehensive insight into various aspects of soil and their properties and to answer the quantitative aspects of soil science, namely, soil mineralogy, soil fertility, soil organic matter, soil moisture and thermal properties of soils. Soil biochemistry is completely untouched. There is a tremendous scope for the study of soil organic matter utilizing narrow band spectroscopy especially in middle and thermal infrared region of electromagnetic spectra. Attempt for soil mapping following digital image processing and GIS is very limited (Lee et al 1988). Spectral properties of soils which are governed by the heterogeneous combination of mineral, organic substances, soil moisture and various salts contain the valuable information related to the crucial soil parameters viz., humic substances, soil texture, thermal properties and primary and secondary minerals. The special feature of soils in the visible (0.4-0.7 µ), near infrared (0.7-1.0 µ) and shortwave infrared (1.0-2.5 µ) spectral regions are associated with physico-chemical properties, emission properties. Thermal infrared region (8-14µ) and different microwave frequencies such as Cbands (5.4 GHz) and L-band (1.25 GHz) reveal the temperature regime and hydrologic regime of soils (Foster 1990). These information are of tremendous value in predicting the biogenic gases from soils quantitatively and in classifying the soils as\ per Soil Taxonomy. The biogenic gases, viz., methane, nitrous oxide, carbon dioxide etc. are the products of soil biochemical processes. The fluxes of biogenic gases can be modelled with various soil properties namely organic matter content, nitrogen content, free iron content, soil reaction, soil moisture status and so on. The potential aspects of the studies on soil, for example, quantitative aspects of soil fertility, soil mineralogy, hydrological aspects and soil biology, need remote sensing and GIS based research. . Ranges of soil variability can be quantitatively established. The use of remote sensing for soil science can certainly be further advanced by enhanced understanding of the process of interaction of electromagnetic spectrum with soil

Geographical information system

The Geographic Information System (GIS) contributes significantly to precision farming by allowing presentation of spatial data in the form of a map. In addition, GIS forms an ideal platform for the storage and management of model input data and the presentation of model results, which the process model provides.

DGPS

This is where GPS comes into picture. In addition, the accuracy, which is the important factor in PF, demands for DGPS (Differential Global Positioning System). GPS makes use of a series of military satellites that identify the location of farm equipment within a meter of an actual site in the field. The value of knowing a precise location within inches is that:

1. Locations of soil samples and the laboratory results can be compared to a soil map,
2. Fertilizer and pesticides can be prescribed to fit soil properties (clay and organic matter content) and soil conditions (relief and drainage),
3. Tillage adjustments can be made as one finds various conditions across the field, and
4. One can monitor and record yield data as one goes across the field.

The Global Positioning System (GPS) technology provides accurate positioning system necessary for field implementation of variable rate technology (VRT). The Internet makes possible the development of a mechanism for effective farm management using remote sensing.

Variable Rate Applicator

Variable-rate technology has been developed apply crop inputs to manage in-field variability. Traditional uniform N applications, in most cases, result in over and under application of N in various parts of the field due to in-field spatial variability. The ability to variably apply optimum levels of N fertilizer corresponding to site-specific field conditions has shown to increase N use efficiency, grain yields, crop decreasing nutrient overload. The variable rate applicator has three components: 1. Control computer 2. Locator and 3. Actuator. The control computer coordinates the field operation. It has a map of desired activity as a function of geographic location. It receives the equipment’s current location from the locator, which has a GPS in it, and decides what to do based upon the map in its memory or data storage. It then issues the command to the actuator, which does the input application (Ravi and Jagadeesha, 2002).

Nutrient stress management

Nutrient stress management is another area where precision farming can help Indian farmers. Most cultivated soils in India are acidic and spatial variation in pH is high. Detecting nutrient stresses using remote sensing and combining data in a GIS can help in site-specific applications of fertilizers and soil amendments such as lime, manure, compost, gypsum and sulphur. This in turn would increase fertilizer use efficiency and reduce nutrient losses. In semi-arid and arid tropics, precision technologies can help growers in scheduling irrigation more profitably by varying the timing, amounts and placement of water. For example drip irrigation, coupled with information from remotely sensed stress conditions (e.g., canopy temperature) can increase the effective use of applied water from 60 to 95% thereby, reducing runoff from 23 to 1% and deep percolation from 18 to 4%.

Some of the ICT initiatives which have been taken up in India includes:

21. Help-line services
22. e-Extension (e- Soil Health card Programme): The Deptt. Of Agriculture, Gujarat State is one of the ambitious programmes which aims to analyses the soil of all the villages of the state & proposes to provide online guidance to farmers on their soil health condition, fertilizer usage and alternative cropping pattern. The website is www.agri.gujarat.gov.in, www.shc.gujarat.gov.in.
23. ITC-e- choupal (http://www.echoupal.com).
24. Village Knowledge centre-hybrid wireless network comprising computers, telephones
25. A AQUA (almost All question Answered) is a multilingual online question and answer forum
26. AGRISNET- uses state-of-the-art broadband satellite technology to establish the network within the country. The website is http://www.apgrinet.gov.in for Andhra Pradesh and http://agriculture.up.nic.in for UP.
27. AGMARKNET is a comprehensive database which links together all the important agricultural produce markets in the country (http://www.stockholmchallenge.se/data/agmarknet).
28. Asha services portal offers services on five different sectors of farming- agri., hort., animal husbandry, fisheries and sericulture.
29. Ashwini Project-involves delivery of high quality healthcare, education, agri., livelihoods training and e-governance to the chosen villages.
30. Community Information Centers (CICs): This project creates awareness among the citizens, particularly those who do not have access to information about the various government scheme.
31. Digital Mandi Project: Creates an exchange for knowledge of farm practices and accurate information for optimizing operations (web site is www.dealindia.org).
32. Digital Ecosystem for Agriculture and rural livelihood- It is a multimedia platform for creation, sharing and dissemination of agricultural information among farmers and experts.
33. Agri Business Centres: It provides a web based solution to the small and medium farmers as well as owners of large landholdings. It brings on a single platform all the stakeholders in agribusiness like farmers and farmer groups, institutions and autonomous bodies, agro machinery and farm equipment makers, cold chain tech., commodity brokers, cooperatives, food processors, pre and post harvest management experts, packaging technology

providers, insurance companies, warehousing and logistics agencies, surveyors and certification agencies.

34. e-KRISHI VIPANAN: It professionalize and reorganize the agriculture trading business of Mandi Board by installing cost effective digital infrastructure using latest advancement in ICT by collecting and delivering real time information, online. It makes the operations more effective, totally transparent, benefiting all stake holders (farmers, traders & the government), empowering them through accurate and timely information for effective decision making.
35. e-krishi (http://www.e-krishi.org)
36. e-Sagu(e-cultivation)system: The eSagu is a ICT-based personalized agro-advisory system.("Sagu" means cultivation in Telugu language). It aims to improve farm productivity by delivering high quality personalized (farm-specific)agro-expert advice in a timely manner to each farm at the farmer's door-steps. In eSagu, the developments in ICT such as (database, internet and digital photography) are extended to improve the performance of agricultural extension services.
37. Query Redress Services: Empowering the farmer community through effective, need-based interventions. It enhances livelihood promotion of farmer community through information dissemination and extension services, using ICT as tool. The project helps the farming community by making available a 10000 plus network of experts to them. Any queries from farmers are forwarded to the ISAP central office from where it is routed to the relevant experts. The service caters to information and knowledge needs of the farmers, professional members of ISAP, individuals and other stakeholders involved in the wider agricultural and allied sectors.
38. Kisan Call Centers: Kisan call centers have been established across the country with a view to leverage the extensive telecom infrastructure in the country to deliver extension services to the farming community. The sole objective is to make agriculture knowledge available at free of cost to the farmers as and when desired. Queries related to agri. And allied sectors are being addressed through the kisan call centres, instantly, in the local language by the experts of agri./hort. Departments, state agril. universities. ICAR institutions etc. There are call centers for every state which are expected to handle traffic from any part of the country. SMSs using telephone and computer, interact with farmers to understand the problem and answer the queries at a call centre. The infrastructure is placed at three locations namely-a professionally managed call center(level-I), a response center in each organization, where services of SMSs are made available (level-II) and the Nodal Cell (level-III).
39. i Kisan (http://www.ikisan.com)
40. ishakti (http://www.stockholmchallenge.se/data/ishakti_bridging_digital_)

Community Radio Stations (CRS)

Timely availability of reliable information is the key to achieve sustainable food production and mitigate risks. Toward this community radio stations will act as an effective tool of communication and create platform to share experiences, perspectives and innovations to increase yield and reduce labour. ISAP has been identified as one of seven organizations in the country to establish community radio station. It will set up the first radio station at Shironj block of Vidhisa district in Madhya Pradesh. In order to help growers, obtaining required certification for organically produced crops, awareness has to be generated through training and distribution of information material. For adopting organic farming for perennial and non perennial fruit crops, aromatic plants, spices etc., additional assistance will be given @ 50% of cost over and above the area expansion programme limited to Rs. 10,000 per hectare for 4 ha per beneficiary, spread over a period of three years i.e. Rs. 4000/in first year and Rs.3000/per ha each in second and third year. For organic cultivation of vegetables, maximum assistance will be limited to Rs. 10,000/per ha spread over a period of three years. Assistance will be used for generating on farm inputs. NHM will also provide financial assistance up to a maximum of Rs 5 lakhs for group of farmers, covering an area of 50 ha, duly recommended by State Government, on a case to case basis, for certification of organic process/produce. This assistance will be given over a period of three years @ Rs. 1.50 lakh each in first and second year and Rs. 2 lakh in third year, to meet cost of documentation, training and charges of service provider and certification agencies accredited by APEDA. Comprehensive guidelines already issued in this regard need to be scrupulously followed. For vermi compost units/ organic production units, assistance will be @ 50% of cost subject to a maximum of Rs. 30,000 per beneficiary for a unit having size of 30’ x 8’ x 2.5’. For smaller units, assistance will be on prorata basis. For HDPE Vermibed of 96 cft size (12’x4’x2’), the cost will be Rs. 10,000/per bed. Specification and design parameter of Agro Textiles HDPE woven beds for vermiculture will conform to BIS standards (IS 15907:2010).

ISAP (Indian Society of Agribusiness Professionals) with support of Microsoft – Unlimited Potential Programme has established ‘Community Technology Learning Centres (CTLCs)’ in remote villages of Maharashtra to provide IT training to 45,000 farmers and unemployed youth. Under two-year programme, ISAP would be setting up 250 CTLCs at village level for imparting IT training to rural community and increase their income earning potential.ISAP is working on online weekly price monitoring system of herbal & medicinal plants with the funding support of National Medicinal Plant Board. ISAP gathers and manages authentic data about the weekly price and demand for 101 medicinal plants from 50-marketing centers in different states of the country. These data are weekly upgraded on the basis of prices and quantity offered for different medicinal plants.

ICT Scheme of ICAR : ARISNET (Agricultural Research Information Network) (www.arisnet.nic.in/ www.icar.org.in)

Indian Council of Agriculture Research (ICAR), under its National Agricultural Research Programme (NARP), initiated establishment of “NICNET based Agricultural Research Information System (ARISNET) in 1990s to network in the Country with the following coverage

• 89 ICAR Institutions,

• 28 State Agricultural Universities,

• 107 Agricultural University Colleges,

• 564 Krishi Vigyan Kendras and

• 850 Agricultural Research Stations.

Content Scheduling and Management System (CSMS): Mass Media (Nav Krishi) Portal (http://dacnet.nic.in/csms) (A Knowledge Management System for Agricultural Extension Services)

• Agricultural Extension programmes are being produced and telecast by as

an average of five days a week for half an hour by a National Channel; Regional Channels and Narrowcasting clusters of Doordarshan (DD) and FM Stations of All India Radio (AIR) in association with Ministry ofAgriculture.

• All Narrowcast centers of DD relay the programme produced by their parent channels.

• To provide a comprehensive and advanced programme schedule; a Content Scheduling & Management System (CSMS); Nav Krishi Portal (G2G & G2C); has been developed by National Informatics Centre (NIC) for reporting and dissemination of Agricultural programmes for the farming community. This will eventually leads to sustainable agricultural development in the country.

Agriculture Knowledge & information systems have to be implemented on priority for rural empowerment and improved livelihoods as Economic growth and industrial growth of India are dependent on productivity in agriculture and allied sectors.

Conclusions

A collaborative approach should be adopted for ICT based developments to make use of repository of information available with various organizations. The knowledge delivery should be "demand-driven". Ministry of Agriculture is implementing various schemes for mainstreaming ICT in Agriculture to improve the Agricultural Productivity on priority. The proposed Common Service Centers and Village Knowledge Centers being set-up by Government of India will further take to harness emerging potential of ICT for the benefit of farmers and all partners of agribusiness offering both synergy and value addition. To provide comprehensive information and advisory services for the benefit. Information services should be made available in regional languages. Bring change in Mindset towards use of ICT. Motivate the people towards building of Comprehensive Database/Information Systems for the farming community. Development of proper advisory services. Development of Expert Systems on What- to- grow-when and where. Bridging the gap through the judicious use of ICT between knowledge and practice for sustainable use of natural resources. Develop linkages between research, technology, and production. Make Reliable and comprehensive Information available any where and any time (one-stop services). The ICON based interactive information Kiosk for computer illiterate farmers for easy, user-friendly, quick/on-line retrieval of relevant information from the concerned research and development as well as extension agencies. Focus be made on the creation and development of web enabled databases, knowledge base management system, data warehouse by IT experts at NIC in coordination with subject matter specialists keeping a view of requirement of applications for end users, which are the farmers. Fundamental as well as customize class room trainings is required to be imparted at all level of staff at R&D and extension agencies for proper utilization of the IT tools. The services from NIC may be obtained to deal with the trainings issues. Only legal software including legal antivirus solutions must be used for effective asecureutilization of Information Technology. An experienced professional Network Administrator/Database Administrator is the prime need of every organization dealing with scientific information for extension of knowledge to end users through appropriate IT tools. Intranet, within ICAR, may be designed for transparency and effective office management, on the pattern of the Intra NIC developed by the NIC and Intra DAC.

References:

Anandaraja, N., Sujhi, G., Ramasubramaniam, M. and Gayatri, G.2010. Modern communication tools in transfer of technology. *In* extension of technologies from labs to farms. Edited by Anandaraja, N., Chandrakandan, K. and Ramasubramaniam, M. Chapter-6:203-218.

Bharati, R.C., Kumar, A. Kumar, U and Chandra,N.2010. Role of information and communication technology in agriculture. *In* Resource conservation technologies for food security. Chapter 41:485-493

Dahama, A.K.2010. Future trends in organic farming. *In* organic farming for sustainable agriculture. Chapter -11:242-262.

Deshmukh, S.N. and Jadhav, S.D.2010. Organic farming principles prospects and problems. Chapter 17:261-271.

Saravanan, R.2010. India. *In* ICTs for @ agricultural extension global experiments, innovations and experiences. Chapter-4:118-167.

Role of communication and information technology in soil fertility improvement in changing climatic situation

Dr. M. K. Meena, Scientist

Land-use change is one of the main drivers of many environmental change processes. It influences the basic resources of land use, including the soil. Its impact on soil often occurs so creepingly that land managers hardly contemplate initiating ameliorative or counterbalance measures. Poor land management has degraded vast amounts of land, reduced our ability to produce enough food, and is a major threat to rural livelihoods in many developing countries. Soil systems like most natural systems, are in dynamic equilibrium. Most changes are slow and imperceptible particularly when viewed in the time frame of human lifespan. However, catastrophic events such as high intensity storms can accelerate erosion processes resulting in measurable changes. The changes are mainly in the structure and composition of the material and such changes are referred to as 'structural changes'. Changes are measurable directly or indirectly or may be inferred from behavior of the system. Many of the changes are related to uses of the soil. These 'performance- related changes are more important as they can be quantified, particularly in economic value terms (Szabolcs 1994). An intimate knowledge of the kind of soils their spatial distribution is a prerequisite in developing rational land use plan for agriculture, forestry, irrigation, drainage etc. Soil resource inventory provides an insight into the potentialities and limitation of soil for its effective exploitation. Soil survey provides an accurate and scientific inventory of different soils, their kind and nature, and extent of distribution so that one can make prediction about their characters and potentialities. It also provides adequate information in terms of land form, terraces, vegetation as well as characteristics of soils (viz., texture, depth, structure, stoniness, drainage, acidity, salinity and so on) which can be utilized for the planning and development. Soil survey constitutes a valuable resource inventory linked with the survival of life on the earth. The technological advancements in the field of remote sensing and Geo- graphical Information System have been a boon for such surveys. This article describes the role of remote sensing and Geographical Information System (GIS) technologies for mapping and characterizing soils at various scales. The spectral behaviour of soil and its components, which is fundamental to deriving information from remote sensing data, is also discussed. Furthermore, the scope of present day remote sensing data for varying levels in-formation generation is also reviewed. The aim of this article is also to suggest measures for the implementation of these information and communication technology in the country with a greater emphasis on the systematic approach towards precision farming operationalisation. Precision farming employs a systems engineering approach to crop production where inputs are applied on "as needed basis;" and is achievable by recent innovations in information technology such as microcomputers, geographic information systems (GIS), positioning technologies (Global Positioning System), and automatic control of farm machinery. It is a holistic approach to micromanage spatial and temporal variability in agricultural landscape based on integrated soil, plant, information, and engineering management technologies as well as economics.

The All India Soil Survey scheme was initiated in 1956 at the Indian Agricultural Research Institute (IARI) with four regional centres located at Delhi, Calcutta, Nagpur and Bangalore to carry out reconnaissance soil survey, correlate and classify soils and prepare small scale soil maps. During 1969, the All India Soil and Land use Survey Organization was bifurcated on the basis of developmental and research work. A new organization "National Bureau of Soil Survey and Land use Planning" was established in Nagpur. The establishment of Indian Photo interpretation Institute (IPI, now Indian Institute of Remote Sensing) in 1966 provided the training support to various soil surveyors on the use of aerial photographs. The initial soil surveys were based on either ground methods or through on a systematic aerial photo interpretation approach. A number of studies on soil survey were carried out by various workers in India in different regions using aerial photographs. Use of satellite remote sensing for soil survey and mapping received appreciation during early 1980s in India, and based on the potential of remote sensing techniques it was decided to map all the States and Union Territories of India on 1:250,000 scale following a multiphase approach consisting of image interpretation, field survey, soil analysis, classification, cartography and printing (Velayutham 1999). The use of digital image processing for soil survey and mapping was initiated with the establishment of National Remote Sensing Agency and Regional Remote Sensing Service Centres.

Development of satellite remote sensing for soil studies

Before the launch of Landsat-1 (in 1972), aerial photographs were being used as a remote sensing tool for soil mapping, and, exhibited their potential in analyzing physiography, land use and erosion status. Subsequently, 1972 onwards satellite data in both digital and analog have been utilized for preparing small scale soil resource maps showing soil sub-groups and their association. The high resolution Landsat TM and Indian Remote Sensing Satellite (IRS) LISS II data which became available during mid eighties, enabled soil scientists to map soils at 1:50,000 scale, which is used for district level planning. At this scale soils could be delineated at association of soil series/family level. The SPOT and IRS -PAN data offered stereo capability, which has improved the soil mapping efforts. Indian Remote Sensing satellites (IRS-1A, 1B, 1C and 1D) provide state-of-the-art database for natural resources inventories. Prior operational work in Remote Sensing with respect to agriculture has been undertaken by the space community which has been summarized by the following table 1.

Table1. Major Indian Remote Sensing Missions for Agriculture (source: Map India Conference 2003)

Mission	Year of launch	Sensors
IRS 1-A, 1-B	1988 1991	LISS-1(72.5resolution;148km Swath), LISS-11(36.25m resolution;142km swath)
IRS P2	1994	LISS III(36m resolution;142km swath
IRS IC,ID	1995 1997	PAN (5.8m resolution ;70m swath(LISS-111(23.5m;70.5m resolution; 141km ,148km swath) WiFS (188.3m resolution 774m swath)
IRS P3	1996	WiFS (188.3 m resolution; 774km swath)
TES	2001	PAN(1m resolution; 14km swath)

RESOURCESAT-1	2001	LISS-IV(6resolution;25km swath)A WiFS (80m resolution;800km swath)
CARTOSAT-1 (IRS-P5)	2002	PANStereo(2.5 km resolution;30km swath)
CARTOSAT-2	2003	PAN Stereo (1km resolution; 12km swath)

Spectral behaviour of soils

Spectral response pattern of soil is generally governed by a number of factors. The properties of soils that govern their spectral reflectance are colour, texture, structure, mineralogy, organic matter, free carbonates, salinity, moisture and the oxides/ hydroxides of iron and manganese. Chemical compositions of the soil influences spectral signature of soils through the absorption processes. In near infrared (NIR) and middle infrared (MIR) domain, absorption feature of soil components in solid phase originate primarily from the vibrations of bounded nuclei. Soil texture refers to relative proportion of sand, Silt & clay and affects the spectral reflectance of the soils due to its influence on water holding capacity and the size of soil particles. Finer the particles size, the soil surface becomes smoother and more incoming solar energy is reflected. An increase in particle size causes a decrease in reflectance. However, silt content of soil is considered as major controlling factor for spectral reflectance. The reflectance becomes lower as the silt content decreases (Hoffer 1978). However, it is commonly observed that sandy soil exhibits higher reflectance than that of clayey soil, which is due to abundance of macro pores and air-soil interface that cause multiple reflection/ scattering.Soil erosion, an important soil degradation process can influence soil spectra. Soil erosion influences indirectly by influencing soil surface roughness and iron content in top soils. So the more is the erosion the more will be soil reflectance (Latz et al. 1984) in the longer wave length of visible and NIR region Technology of remote sensing is advancing. Narrow band imaging spectroscopy in optical and thermal region of electromagnetic spectrum will provide comprehensive insight into various aspects of soil and their properties and to answer the quantitative aspects of soil science, namely, soil mineralogy, soil fertility, soil organic matter, soil moisture and thermal properties of soils. Soil biochemistry is completely untouched. There is a tremendous scope for the study of soil organic matter utilizing narrow band spectroscopy especially in middle and thermal infrared region of electromagnetic spectra. Attempt for soil mapping following digital image processing and GIS is very limited (Lee et al 1988). Spectral properties of soils which are governed by the heterogeneous combination of mineral, organic substances, soil moisture and various salts contain the valuable information related to the crucial soil parameters viz., humic substances, soil texture, thermal properties and primary and secondary minerals. The special feature of soils in the visible (0.4-0.7 µ), near infrared (0.7-1.0 µ) and shortwave infrared (1.0-2.5 µ) spectral regions are associated with physico-chemical properties, emission properties. Thermal infrared region (8-14µ) and different microwave frequencies such as Cbands (5.4 GHz) and L-band (1.25 GHz) reveal the temperature regime and hydrologic regime of soils (Foster 1990). These information are of tremendous value in predicting the biogenic gases from soils quantitatively and in classifying the soils as\ per Soil Taxonomy. The biogenic gases, viz., methane, nitrous oxide, carbon dioxide etc. are the products of soil biochemical processes. The fluxes of biogenic gases can be modelled with various soil properties namely organic matter content, nitrogen content, free iron content, soil reaction, soil moisture status and so on. The potential aspects of the studies on soil, for example, quantitative aspects of soil fertility, soil mineralogy, hydrological aspects and soil biology, need remote sensing and GIS based research. . Ranges of soil variability can be quantitatively established. The use of remote sensing for soil science can certainly be further advanced by enhanced understanding of the process of interaction of electromagnetic spectrum with soil

Relevance of Precision farming in Indian agriculture

The conventional agronomic practices follow a standard management option for a large area irrespective of the variability occurring within and among the field. For decades now, the farmers have been applying fertilizers based on recommendations emanating from research and field trials under specific agro-climatic conditions. Since soil-nutrient, characteristics vary not only from one region to another, but also from field to field (Ladha et al., 2000). Even within a field, there is a need to take into account such variability while applying fertilizers to a particular crop. Consideration of in-field variations in soil fertility and crop conditions and matching the agricultural inputs like seed, fertilizer, irrigation, insecticide, pesticide, etc. in order to optimize the input or maximizing the crop yield from a given quantum of input, is referred to as precision farming or precision agriculture or precision crop management. The term "precision farming" means carefully tailoring the soil and crop management to fit the different conditions found in each field. It is defined as the application of technologies and principles to manage spatial and temporal variability associated with all aspects of agricultural production. (Pierce and Nowak, 1999). It is also referred to as “prescription farming", "site specific farming" or "variable rate technology.” By catering to this variability, called precision farming, one can improve the productivity or reduce the cost of production and diminish the chance of environmental degradation caused by excess use of inputs (Pierce and Nowak, 1999). Thus, mapping and analysis of within field variability is an essential input for precision crop management. Thus, PF involves acquiring the variations in crop or soil properties, mapping, and analyzing the variations, adopting suitable management techniques to maximize the yield. Farmers have been applying fertilizers based on recommendations emanating from research and field trials under specific agro-climatic conditions, which have been extrapolated to a regional level. Since soil nutrient characteristics vary not only between regions and between farms but also from plot to plot (Ladha et al., 2000), and within a field or plot, there is a need to take into account such variability while applying fertilizers to a particular crop. Consideration of in-field/plot variations in soil fertility and crop conditions and matching the agricultural inputs like seed, fertilizer, irrigation, insecticide, pesticide, etc. in order to optimize the input or maximizing the crop yield from a given quantum of input, is referred to as precision farming or precision agriculture or precision crop management.

The information for variability map can be obtained from soil tests for nutrient availability, yield monitors for crop yield, soil samples for organic matter content, information in soil maps, or ground conductivity meters for soil moisture (Mulla, 1997). Generally, the fields are manually sampled along a regular grid and the analyzed results of the samples are interpolated using geostatistical techniques. These techniques are time consuming, labour intensive and in many cases destructive especially, for agricultural situation in India. With small size of landholdings and low income of farmers, the adoption of this methodology in its present form is not feasible. Various workers (Hanson et al., 1995, Taylor et al., 1997, Moran et al, 1997) have shown the advantages of using remote sensing technology to obtain spatially and temporally variable information for precision farming. In an earlier work, Ray et al. (2001) have shown the usefulness of IRS merged data in mapping the variability.

Applications of agricultural inputs at uniform rates across the field without due regard to in-field variations in soil fertility and crop conditions does not yield desirable results in terms of crop yield. The management of in-field variability in soil fertility and crop conditions for improving the crop production and minimizing the environmental impact is the crux of precision farming. Thus, the information on spatial variability in soil fertility status and crop conditions is a pre-requisite for adoption of precision farming. Space technology including global positioning system (GPS) and GIS holds good promise in deriving information on soil attributes and crop yield, and allows monitoring seasonally- variable soil and crop characteristics, namely soil moisture, crop phenology, growth, evapotranspiration, nutrient deficiency, crop disease, and weed and insect infestation, which, in turn, help in optimizing inputs and maximizing crop yield and income. In the 1990s the availability of GPS and GIS to agricultural applications suddenly made it possible to manage very small units (field, peds or ?) rather than managing the field as an average. Reawakened interest in the Law of the Minimum and soil testing held out the prospect of increasing yield while decreasing costs. In many instances soil differences and yield monitors justified the expense of the GPS, GIS technology as increased yields were achieved with fewer chemical inputs. Additionally, the environmental cost of over-application was lessened especially in the case of nitrate and phosphorus fertilization.

Assessment of soil and crop variability, managing the variability and its evaluation are three basic steps in precision farming. The available technologies enable us in understanding the variability and by giving site-specific agronomic recommendations we can manage the variability that make precision farming viable. And finally evaluation must be an integral part of any precision farming system. Precision farming is important because: (i) nutrient variability within a field can be very high affecting optimum fertilizer rates, (ii) yield potential and grain protein can also vary greatly even within one field, affecting fertilizer requirement, (iii) increasing fertilizer use efficiency will become more important with increasing fertilizer costs and environment concerns, (iv) irrigation at critical stages is very important and (v) pest and stress management at early stages helps the farmer to get maximum yield. The study on precision agriculture has been initiated in many research institutions. For Instance space Application. Center (ISRO), Ahmedabad has started experiment in the Central Potato Research Station farm at Jalandhar, Punjab to study the role of remote sensing, GIS and GPS in mapping the variability. M.S. Swaminathan foundation, Chennai, in collaboration with NABARD, has adopted a village in Dindugal district of Tamilnadu for variable rate input application. IARI, New Delhi has drawn up plans to do precision agriculture experiments in the institute’s farm. Project Directorate for Cropping Systems Research (PDCSR), Modipuram, and Meerut (UP) has initiated a project on precision agriculture in collaboration with Central Institute of Agriculture Engineering (CIAE), Bhopal

Components of precision farming

1. Remote Sensing GIS
2. DGPS
3. Variable rate Applicator

Remote sensing and Sensors for PF

Precision farming needs information about mean characteristics of small, relatively homogeneous management zones. This is for Data acquisition of the farms to find the soil, vegetation and other parameters that are amenable for remote sensing. Remote sensing techniques play an important role in precision farming by providing continuous acquired data of agricultural crops. Remote sensors image vegetation, which is growing on different soil types with different water availability, substrate, impact of cultivation, and relief Sensors use for the following applications:

- Soil Properties Sensing: Soil Texture, Structure, and Physical Condition Soil Moisture; Soil Nutrients.
- Crop Sensing: Plant Population; Crop Stress and Nutrient Status.
- Yield Monitoring Systems: Crop Yield; Harvest Swath Width; Crop Moisture:
- Variable Rate Technology Systems: Fertilizer flow; Weed detection, pressure sensors

This study is aided by sensors such as IRS WiFS/LISS-III/PAN and Radarsat ScanSAR. Some of the other studies include: Crop condition assessment, Agricultural drought assessment, Pests and diseases, Land capability and irrigability Nitrogen application often dramatically increases crop yields, but N needs vary spatially across fields and landscapes. Remote sensing collects spatially dense information that may contribute to, or provide feedback about, N management decisions. There is potential to accurately predict N fertilizer need at each point in the field. This would reduce surplus N in the crop production system without reducing crop yield, which would in turn reduce N losses to surface and ground waters. Soil spectral properties (color) are related to soil organic matter and soil moisture levels, factors that influence the N-supplying ability of the soil. Plant spectral properties reflect crop N status and soil N availability, and they can be useful for directing in-season variable-rate N applications. Plant color may also be useful for assessing the adequacy of crop nitrogen supply achieved with a given nitrogen management practice. We outline the current status of these approaches, offer examples, discuss several N management contexts in which these approaches might be used, and consider possible future directions for this technology.

Geographical information system

The Geographic Information System (GIS) contributes significantly to precision farming by allowing presentation of spatial data in the form of a map. In addition, GIS forms an ideal platform for the storage and management of model input data and the presentation of model results, which the process model provides.

DGPS

This is where GPS comes into picture. In addition, the accuracy, which is the important factor in PF, demands for DGPS (Differential Global Positioning System). GPS makes use of a series of military satellites that identify the location of farm equipment within a meter of an actual site in the field. The value of knowing a precise location within inches is that:

1. Locations of soil samples and the laboratory results can be compared to a soil map,
2. Fertilizer and pesticides can be prescribed to fit soil properties (clay and organic matter content) and soil conditions (relief and drainage),
3. Tillage adjustments can be made as one finds various conditions across the field, and
4. One can monitor and record yield data as one goes across the field.

The Global Positioning System (GPS) technology provides accurate positioning system necessary for field implementation of variable rate technology (VRT). The Internet makes possible the development of a mechanism for effective farm management using remote sensing.

Variable Rate Applicator

Variable-rate technology has been developed apply crop inputs to manage in-field variability. Traditional uniform N applications, in most cases, result in over and under application of N in various parts of the field due to in-field spatial variability. The ability to variably apply optimum levels of N fertilizer corresponding to site-specific field conditions has shown to increase N use efficiency, grain yields, crop decreasing nutrient overload. The variable rate applicator has three components: 1. Control computer 2. Locator and 3. Actuator. The control computer coordinates the field operation. It has a map of desired activity as a function of geographic location. It receives the equipment's current location from the locator, which has a GPS in it, and decides what to do based upon the map in its memory or data storage. It then issues the command to the actuator, which does the input application (Ravi and Jagadeesha, 2002).

Nutrient stress management

Nutrient stress management is another area where precision farming can help Indian farmers. Most cultivated soils in India are acidic and spatial variation in pH is high. Detecting nutrient stresses using remote sensing and combining data in a GIS can help in site-specific applications of fertilizers and soil amendments such as lime, manure, compost, gypsum and sulphur. This in turn would increase fertilizer use efficiency and reduce nutrient losses. In semi-arid and arid tropics, precision technologies can help growers in scheduling irrigation more profitably by varying the timing, amounts and placement of water. For example drip irrigation, coupled with information from remotely sensed stress conditions (e.g., canopy temperature) can increase the effective use of applied water from 60 to 95% thereby, reducing runoff from 23 to 1% and deep percolation from 18 to 4%.

Conclusion

Site-specific nutrient management can increase incomes in small, family field plot-scale systems through the identification of soilvariability and implementation of rational nutrient application**.** It can be rightly stated that though Information communication Technology in the agriculture is in growing stage in the Indian context. It has just started to spread its shoots, but withits immense potential to standardize and regulate the agricultural processes andsolve the problems, it is sure that ICT will be one of the most important areas in thenear future for agricultural development.It is hoped that Information Technology will bring a highly developed agriculture by its worthwhile contributions to the society by narrowing down the enormous gap between the researchers and farmers. It is suggested that the farmers are to be made aware of the utility of the Internet and other related information regarding Information Technology. In these days of increasing input costs, decreasing commodity prices and environmental concerns, farmers and government authorities are looking for new ways to increase efficiency of resources, cut costs and subscribe to sustainable agriculture. Precision farming technology looks promising as a future farming tool, however its effective use in Indian agriculture is yet to be realized.

Role of Information and Communication Technology (ICT) in Precision Farming under Changing Climate Situation

Anil Kumar Singh
Division of land and water management
ICAR- Research Complex for Eastern Region Patna Bihar-800 014
Email:aksingh_14k@yahoo.co.in

Indian Economy is growing day by day; being a more than trillion dollar economy, Now Indian economy is no more backward economy by any yardstick due to its inclusive development (growing with 8 plus percent GDP) left behind *Hindu* rate of growth (below 5 %GDP), provided space for all-round development. Information and communication technology (ICT) are the among the fastest growing service sector, neither any one is unaffected by this revolution nor agriculture. Increased accessibility of information and communication tools and techniques by common man and it's adventitious and multiple usages prove this boon for humanity. Like other arena of life, agricultural production system is also harnessing its (ICT) capabilities for its own benefits in particulars as well as for serving humanity with added responsibilities in general. Agriculture in India is never treated as business, because being an integral part of our cultural heritage and as a part and partial of daily routine. Presently farming is facing bigger challenge than ever since civilization for its sustainability in profitable manner; obviously farming activities are potentially threatened by global warming and impending climate change circumstances. Conceivably precision farming is befitting reply not only for improving production but also enhancing factor productivity. I am very much optimistic that blend of various precision farming techniques that can suit for site specific agricultural production coupled with the help of faster expanding information and communication technology (ICT) can not only in mitigating Changing Climate but also provide unique opportunity for profitable agricultural production system. Greater responsibilities are sensed by Information and Communication Technology (ICT) by virtue of its potentiality usefulness for fragile Indian agricultural production system. This presentation is based on three basic component and due weighted has been given to the (1) ICT and (2) Precision farming and only relevant introductory information has been narrated in the beginning about (3)climate change and its impact on agriculture in brief because nature and scope of paper does not permit detailed discussion on climate chance.

Changing Climate Scenario:

Climate is usually defined as the average weather or more rigorously as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. Climate change may be due to natural internal processes or external forcing, or to persistent anthropogenic changes in the composition of the atmosphere or in land use, impact of rise in temperature and CO_2 concentration on crops yield may be negative. The estimated that a 2°C increase in air temperature could decrease rice yield by about 0.75 tons ha^{-1} in high yielding areas. It was further indicated that due to climate change, there is reduction in crop yield of 10 to 40 per cent at the present yield level by the turn of the century. This complex situation not only present great challenge to humanity but also provide unique opportunity to combats this natural cum man made reality. If not managed with sensitivity may be leads to havoc for human civilization. The green house gases are the main culprits of the global warming and climate change. The green house gases like carbon dioxide, methane, and nitrous oxide are playing hazards in the present times. Global warming poses a potential threat to agricultural production and productivity throughout the world and this might affect the crop yields, incidence of weeds, pests and plant diseases and the economic costs of agricultural production. Crop productivity is projected to decrease even by small rise in temperature (1-2°C) at the lower latitudes, especially in the seasonal dry and tropical regions (IPCC, 2007).

Information and Communication Technology (ICT) Vis -a-Vis E-Agriculture:

The agricultural sector in India is currently passing through a difficult phase. India is moving towards an agricultural emergency due to lack of attention, insufficient land reforms, defective land management, non-providing of fair prices to farmers for their crops, inadequate investment in irrigational and agricultural infrastructure in India, etc. India's food production and productivity is declining while its food consumption is increasing. The position has further been worsened due to use of food grains to meet the demands of bio fuels. Even the solution of import of food grains would be troublesome, as India does not have ports and logistical systems for large-scale food imports. The application of Information and Communication Technology (ICT) in agriculture is increasingly important. E-Agriculture is an emerging field focusing on the enhancement of agricultural and rural development through improved information and communication processes. More specifically, e-Agriculture involves the conceptualization, design, development, evaluation and application of innovative ways to use information and communication technologies (ICT) in the rural domain, with a primary focus on agriculture. E-Agriculture is a relatively new term and we fully expect its scope to change and evolve as our understanding of the area grows.

Agriculture production system mainly consist of:

1. Crop cultivation,
2. Water management,
3. Fertilizer Application,
4. Fertigation,
5. Pest management,
6. Harvesting,
7. Post harvest
8. handling,
9. Transporting of food/food products,
10. Packaging,
11. Food preservation,
12. Food processing/value addition,
13. Food quality management,
14. Food safety, Food storage,
15. Food marketing

All stakeholders of agriculture production system need information and knowledge about these phases to manage them efficiently. Any system applied for getting information and knowledge for making decisions in any industry should deliver accurate, complete, concise information in time or on time. The information provided by the system must be in user-friendly form, easy to access, cost-effective and well protected from unauthorized accesses. Information and Communication Technology (ICT) can play a significant role in maintaining the above mentioned properties of information as it consists of three main technologies.

They are: Computer Technology, Communication Technology and Information Management Technology. These technologies are applied for processing, exchanging and managing data, information and knowledge. The tools provided by ICT are having ability to:

1. Record text, drawings, photographs, audio, video, process descriptions, and other information in digital formats,
2. Produce exact duplicates of such information at significantly lower cost,
3. Transfer information and knowledge rapidly over large distances through communications networks.
4. Develop standardized algorithms to large quantities of information relatively rapidly.
5. Achieve greater interactivity in communicating, evaluating, producing and sharing useful information and knowledge.

Applications of ICT in agriculture sector: The main focus of this article is to elaborate how the achievements of ICT can be applied in Agriculture sector and its development. The main applications of ICT in agriculture sector are listed below.

1. Application of office automation
2. Application of Knowledge Management System
3. Application of E-learning
4. Application of E-commerce
5. Application of ICT for managing Agricultural Resources and Services
6. Application of Wireless Technologies
7. Application of Remote Sensing
8. Application of GPS
9. Application of GIS
10. Application of Modeling
11. External links

Methods of Wireless Connectivity

- IrDA:
- HF, SW, VHF, and UHF Radio Frequencies:
- Wireless 3G and Cellular Technology:
- Wireless Networks:
- Bluetooth
- GPS
- Satellite Internet and Video Connectivity

Common Applications of Wireless in Agriculture and Natural Resources: There are many applications in agriculture that can use wireless technologies. Some examples include:

1. Monitoring pesticide and herbicide applications.
2. Animal tracking and identification.
3. Monitoring water or flood levels.
4. Indicate warning for frost events.
5. Monitor crop health, rainfall, temperature and other meterological data.
6. Track shipments of perishable crops and crop inputs.
7. Monitor equipment movement and performance.

8. Web cameras to view hazardous or remote areas.
9. Odor, gas and other environmental indicators for livestock housing facilities.
10. Integrating GPS data into Geographic Information Systems.
11. Precision agriculture applications in data collection and reporting.
12. Food safety and security through continuous tracking capabilities from production (knowing what pesticides or other treatments have been used) and packing and shipping of products.
13. Agro-Security by reducing theft of farm products, vandalism of property, and detection of bio-chemicals.

Wireless Use in Crop Management and Precision Agriculture:

1. Topo and elevation mapping
2. Soil sampling
3. Yield monitoring
4. Soil electromagnetic conductivity mapping
5. Satellite and aerial imagery
6. Soil Moisture for irrigation needs
7. Crop input record keeping and tracking
8. Crop scouting of weeds, diseases, and insects
9. Meteorological data collection

Some traditional limitations in collecting this data includes timeliness of transferring data to the appropriate locations or central databases and loosing data from equipment malfunction or battery loss. Data can be collected in real-time or after a specific process has been completed. Information can also come in large sizes so the transfer rate of data needs to be handled through larger bandwidth and data storage capabilities. Another benefit of using wireless technology is that it can send several sources of data in real-time to one central location like a server database system. Allowing data to be pooled to a central location allows multiple users to utilize that data when they need it. For example, weed scouting data collected in the field from a consultant using a handheld PDA equipped to a cellular phone or local wireless network system relays treatment information to office server. Server-side software generates an appropriate application map to grower and sent on to commercial chemical applicator for application at the same time.

Technology Dissemination

Extension System has crumbled - needs to be re-look

- Farming has become increasingly complex
- Small farm holder, with little education, finds it difficult to make right choices
- Therefore Effective communication between technology developer-provider and technology user has becomes crucial

Initiatives on Transfer of Technology

1. One Krishi Vigyan Kendra (KVK) in each district of the country
2. Institute-Village Linkage Programme for Technology Assessment & Refinement (IVLP)
3. Agricultural Technology Information Centres (ATIC) at selected SAUs and ICAR Institutes
4. ATMA in selected states of the country
5. Toll-free Kisan Call Centres

Status of applications of ICT in Agriculture sector in India

Tata Kisan Kendra: The concept of precision farming being implemented by the TKKs has the potential to catapult rural India from the bullock-cart age into the new era of satellites and IT. TCL's extension services, brought to farmers through the TKKs, use remote-sensing technology to analyze soil, inform about crop health, pest attacks and coverage of various crops predicting the final output. This helps farmers adapt quickly to changing conditions. The result: healthier crops, higher yields and enhanced incomes for farmers.

Government organization: Space Applications Centre (ISRO), M.S. Swaminathan Research Foundation, Chennai, Indian Agricultural Research Institute, New Delhi, and Project Directorate of Cropping Systems Research, Modipuram, had started working in this direction and in soon it will help the Indian farmers harvest the fruits of frontier technologies without compromising on the quality of land. ISRO has initiated Gramsat project in Orissa. Forecasting the yield of mono and multiple crops is being done at NRSA. Acreage estimates and crop inventory is being done during Kharif and Rabi seasons for Rice, which is the major crop grown in our India. Other crops like Banana, Chillies, Cotton, Maize, Sugarcane and Tobacco are also being inventoried. Satellite data can also delineate different crops that are grownin the same area, and an inventory of each of the crops can be done.

Problems in adopting ICT in agriculture sector in India

1. Illiteracy of farmers
2. Knowledge and technological gaps
3. High cost of precision farming equipments
4. Lack of availability of such equipments
5. Poor economic condition of farmers
6. Small land holdings
7.

Steps to be taken for implementing ICT in agriculture sector in India

Creation of multidisciplinary teams involving agricultural scientists in various fields, engineers, manufacturers and economists to study the overall scope of precision agriculture.

1. Formation of farmer’s co-operatives since many of the precision agriculture tools are costly (GIS, GPS, RS, etc.).
2. Pilot study should be conducted on farmer’s field to show the results of precision agriculture implementation.
3. Government legislation restraining farmers using indiscriminate farm inputs and thereby causing ecological/environmental imbalance would induce the farmer to go for alternative approach.
4. Creating awareness amongst farmers about consequences of applying imbalanced doses of farm inputs like irrigation, fertilizers, insecticides and pesticides

Precision Farming

Crop production involves a combination of practices revolving around soil, crop, climate and management factors. The factors affecting crop yields and environmental sensitivity vary in both space and time. Thus a new concept has arisen to manage the space-time continuum in crop production called precision agricultural management or precision agriculture or site specific management, which is concerned with the management of variability of agricultural resources in the dimensions of both space and time. Precision agriculture is the application of technologies and principles to manage special and temporal variability associated with all aspects of agricultural production for the purpose of improving crop performance and environmental quality.

Definitions of precision farming:

Currently, no precision agriculture system exist; rather, various components of traditional crop management systems have been addressed separately regarding their potential for site specific management, perhaps most notably soil fertility. PF is a management philosophy or approach to the farm and is not a definable prescriptive system. It is essentially more precise farm management made possible by modern technology. The variations occurring in crop or soil properties within a field are noted, mapped and then management actions are taken as a consequence of continued assessment of the spatial variability within that field. Development of geometrics technology in the later part of the 20th century has aided in the adoption of site-specific management systems using remote sensing (RS), GPS, and geographical information system (GIS). This approach is called PF or site-specific management. It is a paradigm shift from conventional management practice of soil and crop in consequence with spatial variability. It is a refinement of good whole field management, where management decisions are adjusted to suit variations in resource conditions. PF requires special tools and resources to recognize the inherent spatial variability associated with soil characteristics, crop growth and to prescribe the most appropriate management strategy on a site-specific basis. It offers a potential step change in productive efficiency. Fundamentally, PF acknowledges the conditions for agricultural production as determined by soil, weather and prior management across space and over time. Considering this inherent variability, management decisions should be specific to time and place, rather than rigidly scheduled and uniform.

Synonyms of precision farming:

Precision farming, Information-intensive agriculture, Prescription farming, Target farming, Site specific crop management, Variable rate management, Farming by soil, Grid soil sampling agriculture, Grid farming, GPS farming , Farming by the inch, Farming by the foot, Smart farming, Farming by Computer, Farming by satellite, Computer-assisted Agriculture, Automated Agriculture, Cyberfarm, etc.

Precision Farming- Global Context

"Precision farming is information and technology based farm management system to identify, analyze and manage variability within fields for optimum profitability, sustainability and protection of the land resource**"**

Precision Farming- Indian Context

1. Concept originated in west; large holdings and high level of farm mechanization.
2. In India holdings are small; farmers have poor resource base and low level of formal education. Therefore, the concept redefined as "Precise application of technologies and inputs based on soil, crop, weather and market demands, to maximize sustainable productivity and profitability"
3. How to increase profitability?
4. Reducing the cost of cultivation, Zero tillage, efficient use of water,efficient use of plant nutrients and agro-chemicals

5. Increasing productivity per unit land
6. Technologies for improving the quality of farm production Crop diversification
7. Processing and value addition
8. Use of land according to its capability
9. Organic farming, pressurized irrigation, plasticulture
10. Protected cultivation
11. Knowledge-based marketing and export
12. Subsidiary on-farm and off-farm vocations for
13. Supplementary income

Criteria's for precision agriculture

1. Variability exist in the system
2. Ability to identify and quantify variability.
3. Mapping and analysis of field variability
4. Ability to efficient inputs management practices to improve productivity and profitability.

Enabling technologies for precision agriculture

1. Georeferenced Information
2. Global Positioning System
3. Geographic Information Systems
4. Mapping Software
5. Yield Mapping Systems
6. Variable-Rate Technologies
7. Ground based Sensors (GBS)
8. Remote Sensing
9. Decision Support Systems

Perspectives of precision farming

1. **Agronomical perspective** : Adjust cultural practices for real needs of the crop (e.g., better fertilization)
2. **Technical perspective** : Better time management (e.g. planification of agricultural activity)
3. **Environmental perspective** : Reduction of agricultural impacts (better estimation of crop nitrogen needs implying limitation of nitrogen run-off)
4. **Economical perspective** : Increase of the output and/or reduction of the input, increase of efficiency (e.g., lower cost of nitrogen fertilization practice)
5. **Crop productivity perspective:**

a. Nutrient supply according to soil variation may be most significant aspect of PA which aims at improving the input – output characteristics of the soil and crop system as they vary in space and time.
b. Information and management technology are combined into a production systems to cater the variability, that can increase production efficiency by allow more efficient input use through efficient application.
c. Precision instruments are able to complete in-field operations like cultivation, seed sowing, application of fertilizers & pesticides and harvest timely, which enhance the crop productivity.

d. Precision farming provides sufficient understanding of the processes involved to apply inputs in such a way as to be able to achieve a particular goal. The goal, however, might not necessarily mean maximum yield but may be to optimize financial advantage while operating within environmental constraints
e. Precision farming involves the use of spatial asset allocation and management to distribute available time and money where it is most needed and will provide the best return.
f. Precision agriculture provides tools for tailoring production inputs to specific plots within a field, thus potentially reducing input costs, increasing yields, and reducing environmental impacts by better matching inputs applied to crop needs.
g. Precision agriculture technology is paving the way for agricultural producers by allowing for precise management of inputs. The appropriate management processes and information needs vary among different environments, but also among different decisions to be made.

Keep in mind about precision farming

a. Precision farming is a management process, not a technology.
b. Measure the spatial and temporal variability
c. Assess the significance of the variability in both economic and environmental terms
d. State the required outcome for the crop and the farm.
e. Consider the special requirements of the crop and the field
f. Establish ways to manage the variability to achieve the expected outcome

Summary:

Information and communication technology (ICT) is unique blend of tools and technology for providing information in fastest way and correct manner without losing content and most importantly without any communication gap, where as precision farming is smart way of farming under changing climate scenario.

Suggested readings:

1. Barnett, V.; Landau, S.; Colls, J.J.; Craigon, J.; Mitchell, R.A.C. and Payne, R.W. (1997) Predicting wheat yields: The search for vailid and precise models. In "Precision Agriculture: Spatial and Temporal Variability of Environmental Quality" (J.V. Lake, G.R. Bock and J.A. Goode. Eds.). pp. 79-92. Wiley, New Yark.

2. Clark, R.L. (1996) A comparison of rapid GPS techniques for topographic mapping. *In* "Proceedings of the Third International Conference on Precision Agriculture, Minneapolis, MN, 23-26 June 1996" (P.C. Robert, R.H. Rust and W.E. Larson, Eds.), ASA Miscellaneous Publication. pp. 651-662. ASA, CSSA and SSSA, Madison, WI.

3. Dawson, C.J. (1997) *Precision agriculture* (ed. Stafford, J.V.). BIOS Scientific Publishers Ltd. Vol. 1. pp. 45-58.

4. Kropff, M.J. and Lotz, L.A.P. (1997) Modeling for precision weed management. *In* "Precision Agriculture: Spatial and Temporal Variability of Environmental Quality" (J.V. Lake, G.R. Bock and J.A. Good Eds.), pp. 182-200. Wiley, New York.

5. Lange, A.F. (1996) Centimeter accuracy differential GPS foe precision agriculture applications. *In* "Proceedings of the Third International Conference on Precision Agriculture, Minneapolis, MN, 23-26 June 1996" (P.C. Robert, R.H. Rust and W.E. Larson, Eds.), ASA Miscellaneous Publication. pp. 675-680. ASA, CSSA and SSSA, Madison, WI.

Role of Information and Communication Technology in Soil quality assessment

Dr. K. Rajan
Scientist (Soil Science)

Soil quality is the capacity of a specific kind of soil to function within natural or managed ecosystem boundaries to sustain plant and animal productivity, maintain or enhance water and air quality and support human health and habitation. Soil Science Society of America Ad Hoc committee on soil health proposed a definition that soil quality is " The capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries to sustain plant and animal productivity, maintain or enhance water and air quality and support human health and habitation". The soil function describes what the soil does. Soil functions are general capabilities of soils that are important for various agricultural, environmental, nature protection, landscape architecture and urban applications. Soil functions are: (1) sustaining biological activity, diversity, and productivity; (2) regulating and partitioning water and solute flow; (3) filtering and buffering, degrading, immobilizing, and detoxifying organic and inorganic materials, including industrial and municipal by-products and atmospheric deposition; (4) storing and cycling nutrients and other elements within the earth's biosphere; and (5) providing support of socioeconomic structures and protection for archeological treasures associated with human habitation. Soils vary naturally in their capacity to function; therefore, quality is specific to each kind of soil. This concept encompasses two distinct but interconnected parts: inherent quality and dynamic quality. Characteristics, such as texture, mineralogy, etc., are innate soil properties determined by the factors of soil formation such as climate, topography, vegetation, parent material, and time. Collectively, these properties determine the inherent quality of a soil. They help compare one soil to another and evaluate soils for specific uses. For example, all else being equal, a loamy soil will have a higher water holding capacity than a sandy soil; thus, the loamy soil has a higher inherent soil quality. This concept is generally referred to as soil capability. Map unit descriptions in soil survey reports are based on differences in the inherent properties of soils. More recently, soil quality has come to refer to the dynamic quality of soils, defined as the changing nature of soil properties resulting from human use and management. Some management practices, such as the use of cover crops, increase organic matter and can have a positive effect on soil quality. Other management practices, such as tilling the soil when wet, adversely affect soil. Soil quality assessments are thus used to evaluate the effects of management on the health of the soil. Or else, Soil quality is evaluated to learn about the effects of management practices on soil function.

Reasons for evaluating soil quality fall into four categories:

1. Awareness and education
2. Evaluation of practice effects and trouble-shooting
3. Assessment as monitoring tool
4. Evaluation of alternative practices

1. Awareness and education: The soil quality concept emphasizes an ecological approach to land management. Management actions don't have simple, single effects in complex systems, such as soil. Management has multiple effects, both direct and indirect. For example, tillage is used to loosen surface soil, prepare the seedbed, and control weeds and pests. But tillage can also break up soil structure, speed the decomposition and loss of organic matter, increase the threat of erosion, destroy the habitat of helpful organisms, and cause compaction. Understanding the problems and management options is a first step towards improved land management.

2. Evaluation of practice effects and trouble-shooting: Soil quality is often referred to as "Soil Health" because of objectives similar to the monitoring and maintenance of human health. Doctors monitor health indicators and watch for irregularities or declines in status. The set of health indicators measured during a check-up is familiar to all of us: temperature, pulse, blood pressure, heartbeat, urine samples, etc. Monitoring of these indicators may reveal potential problems even before painful symptoms occur; the earlier problems are observed, the easier they are to treat.

3. Assessment as a monitoring tool: Soil indicators that appear irregular or decline over time provide a signal that some aspect of the management should be reconsidered. Although soil fertility testing already serves this role in regard to plant nutrition, soil quality assessment expands this to include the wider range of soil functions and environmental outcomes. Soil quality measurements are also a way of investigating specific problems. Low productivity in a specific area may have several causes of which low nutrient status may only be one, or indeed a symptom rather than a cause. When soil quality is assessed over time, it can tell us something about the sustainability of management practices.

4. Evaluation of alternative practices: Beyond awareness and evaluating current practices, soil quality assessment methods provide a framework for comparing management practices and deciding which management options provide the greatest good, whether for one's farming operation or at a watershed or regional scale.

Communication technologies for soil quality assessment: Assessment of soil quality can be done in farm level and also for regional level. In regional level it can be done based on soil, climate and land uses. Some useful technologies aid to understand nature of soil and its problems due to management practices. Communication and Information technology has developed several folds in the recent past. The vision on identifying the status of natural resources also widened. Soil quality assessment is being done with some useful technologies. Remote sensing is any process that collects data about an object from a remote location. Geographers use a number of mechanical devices to achieve this process. These devices contain advanced sensors that can capture information via the reflection or emission of radiation from objects. Devices used for remote sensing are constructed to sense certain wavelength bands. The objects that are sensed have particular spectral signatures and one has to match the object to the sensor. The area reported with productivity decline is demarcated. Remote sensing products are collected and interpreted for low productivity with visual observations.

1. Aerial photographs: The simplest form of remote sensing uses photographic cameras to record information from ***visible*** or ***near*** infrared wavelengths. In the late 1800s, cameras were positioned above the Earth's surface in balloons or kites to take oblique aerial photographs of the landscape. Many of these images were used to construct topographic and other types of reference maps of the natural and human-made features found on the Earth's surface.

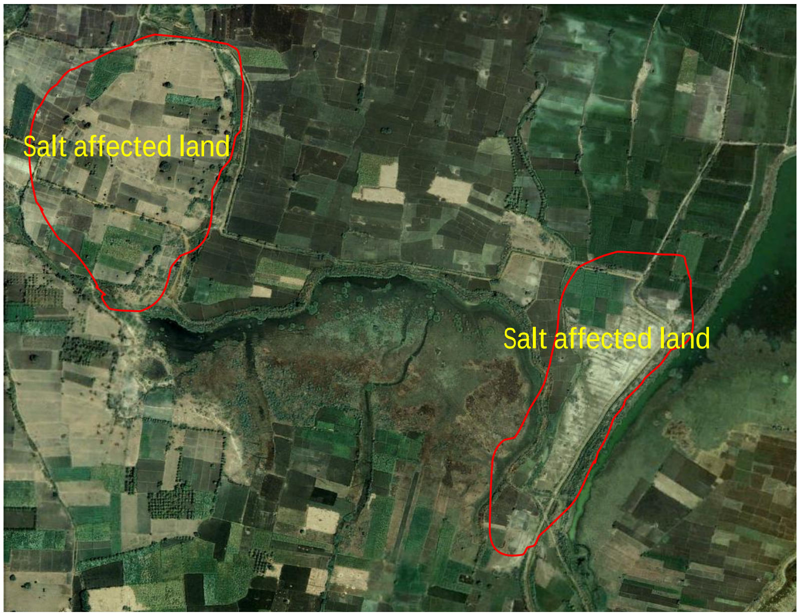
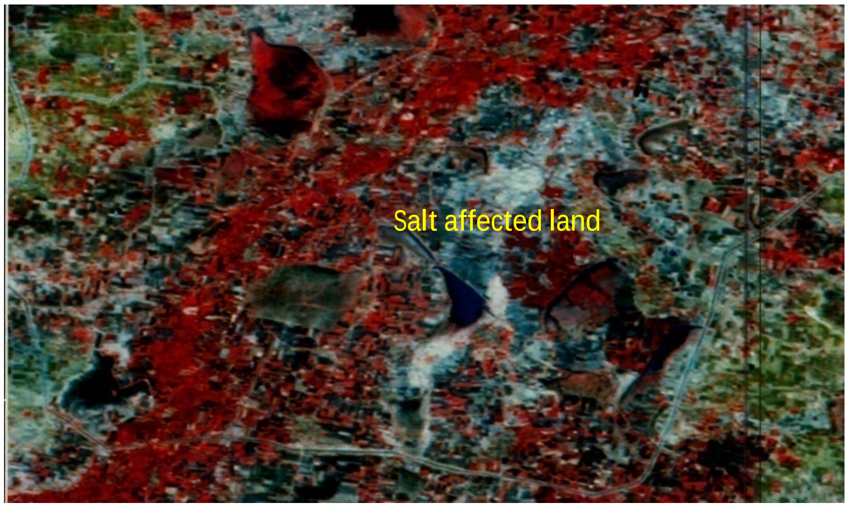


Fig. 1 Aerial photographs of salt affected lands-Chamrajnagar District, Karnataka

Soil quality can be assessed from aerial photography. Areas without vegetation, with high reflectance, irregular in shape are demarcated and it can be examined for eroded or salt affected lands. Figure 1 shows the areas of salt affected lands with high reflectance.

3. **Satellite imagery:** In the 1960s, the deployment of high altitude satellite caused a revolution in remote sensing. Many orbiting objects were outfitted with sensors to complete specific remote sensing jobs. Remote sensing of the Earth's climate for weather forecasting began with the launching of a number of satellites called TIROS. Over time sensors became more sophisticated and some of them were used to monitor the Earth's surface for a number of applications outside of weather forecasting (LANDSAT, SPOT, and RADARSAT). Recognizing objects from a remotely sensed image is often a difficult process. Many objects are hard to identify because their appearance in the image is unfamiliar to our memories. We see objects in our environment mainly from a oblique perspective. Objects that are remotely sensed are often imaged from above and the sensors used in the imaging process may be recording electromagnetic signatures that are outside human vision. To aid in object recognition users often use a methodical process that identifies features based on shape, image tone or color, pattern, shadow, and texture.
4. Reflectance of electromagnetic radiation forms the basis for soil quality assessment. Irregular white patches in the irrigation command of Kabini river shows the salt affected areas.



Salt affected land

Fig. 2 Satellite imagery of salt affected lands-Chamrajnagar District, Karnataka

4. **Microwave remote sensing:** Microwave sensing encompasses both active and passive forms of remote sensing. the microwave portion of the spectrum covers the range from approximately 1cm to 1m in wavelength. Because of their long wavelengths, compared to the visible and infrared, microwaves have special properties that are important for remote sensing. Longer wavelength microwave radiation can penetrate through cloud cover, haze, dust, and all but the heaviest rainfall as the longer wavelengths are not susceptible to atmospheric scattering which affects shorter optical wavelengths. This property allows detection of microwave energy under almost all weather and environmental conditions so that data can be collected at any time.Passive microwave sensing is similar in concept to thermal remote sensing. All objects emit microwave energy of some magnitude, but the amounts are generally very small. A passive microwave sensor detects the naturally emitted microwave energy within its field of view. This emitted energy is related to the temperature and moisture properties of the emitting object or surface. Passive microwave sensors are typically radiometers or scanners and operate in much the same manner as systems discussed previously except that an antenna is used to detect and record the microwave energy.Active microwave sensors provide their own source of microwave radiation to illuminate the target. Active microwave sensors are generally divided into two distinct categories: **imaging and non-imaging**. The most common form of imaging active microwave sensors is RADAR. **RADAR** is an acronym for **RA**dio **D**etection **A**nd **R**anging, which essentially characterizes the function and operation of a radar sensor. The sensor transmits a microwave (radio) signal towards the target and detects the backscattered portion of the signal. The strength of the backscattered signal is measured to discriminate between different targets and the time delay between the transmitted and reflected signals determines the distance (or **range**) to the target.

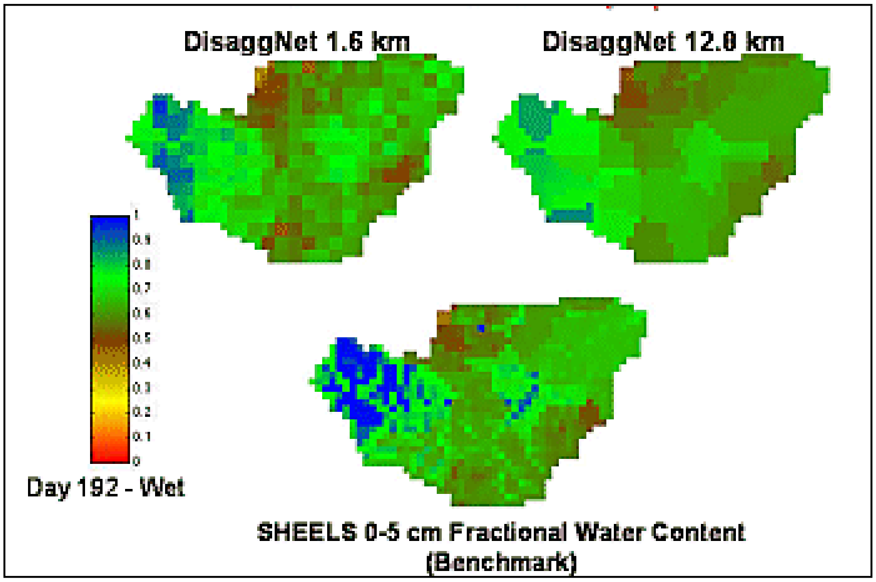


Fig. 3 Soil moisture map in an area developed from microwave remote sensing

Microwave remote sensing is used for soil moisture estimation. Soil moisture is an important component of the hydrological cycle. It contributes significantly to the water and energy flux from the surface of the earth, which in turn drives the atmospheric circulation. Remote sensing-based measurement of soil moisture is a better alternative to get this information over a large area (Fig. 3)

Information technologies for soil quality assessment

The data collected from the field using communication technologies will become input for information technologies. Analysis of soil samples brought from the field gives an idea of status of the soil quality indicators such as physical, chemical and biological indicators as follows.

i. Soil physical properties: Bulk density, Available soil water, Micro-aggregates and Total porosity.

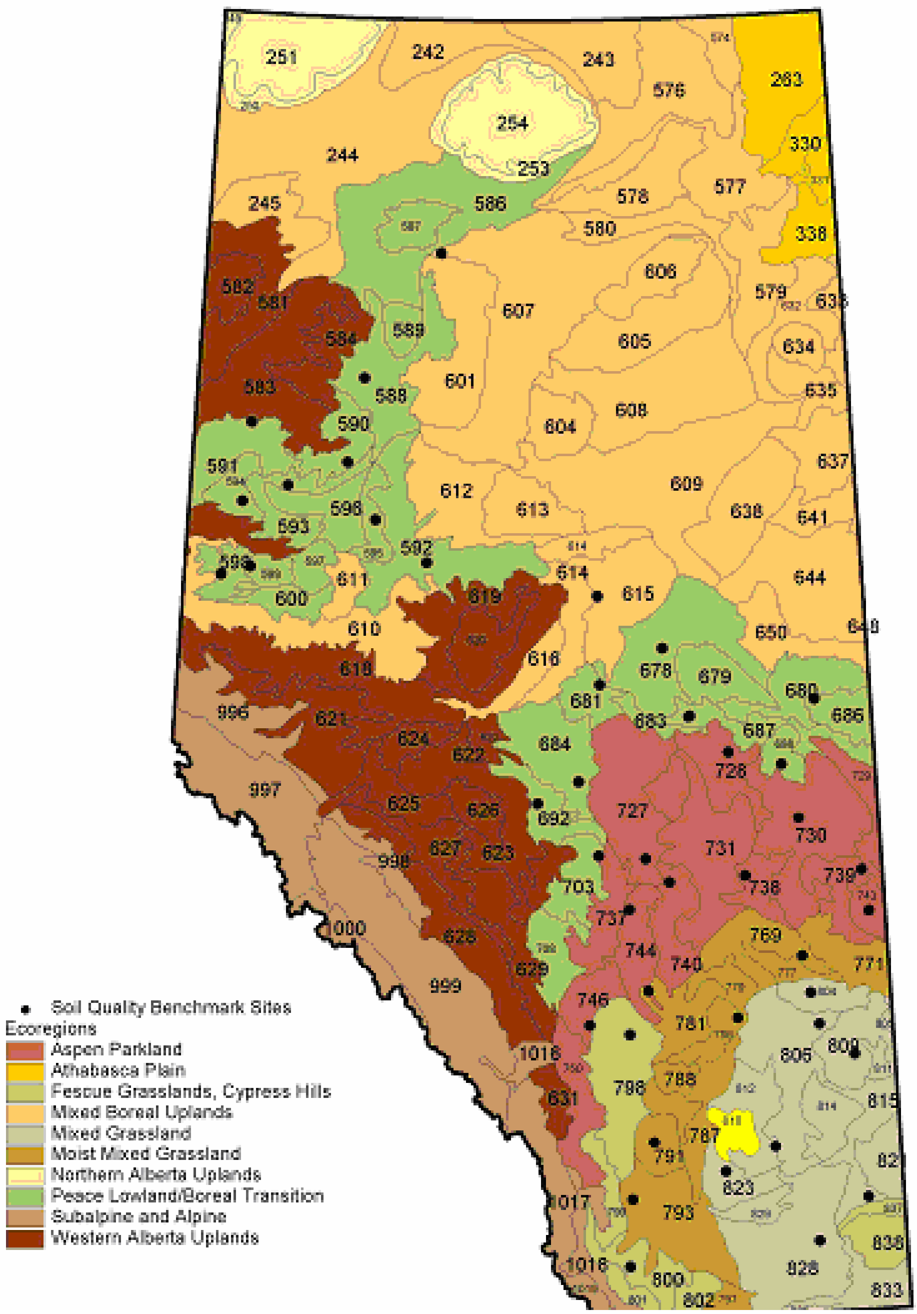
ii. Soil chemical properties: Electric conductivity, pH, Available N, Available P, Available K, Available Cu, Available Fe, Available Mn, and Available Zn

iii. Soil biological properties: Organic carbon, Dehydrogenase activity and Urease activity

These quality parameters are used in information technologies to assess the soil quality.

1. **Geographic Information Systems:** GIS are another important tool. These systems combine computer cartography with database management software. GIS is used to: a) measure natural and human phenomena and processes from a spatial perspective; b) store these measurements in digital form used a computer database and digital maps; c) analyze collected measurements. Geographic information systems (GIS) or geospatial information systems is a set of tools that captures, stores, analyzes, manages, and presents data that are linked to location(s). In the simplest terms, GIS is the merging of cartography, statistical analysis, and database

technology. GIS may be used in archaeology, geography, cartography, remote sensing, land surveying, public utility management, natural resource management, precision agriculture, photogrammetry, urban planning, emergency management, navigation, aerial video, and localized search engines. As GIS can be thought of as a system, it digitally creates and "manipulates" spatial areas that may be jurisdictional, purpose or application oriented for which a specific GIS is developed. Hence, a GIS developed for an application, jurisdiction, enterprise, or purpose may not be necessarily interoperable or compatible with a GIS that has been developed for some other application, jurisdiction, enterprise, or purpose. GIS applications are tools that allow users to create interactive queries (user-created searches), analyze spatial information, edit data, maps, and present the results of all these operations.[1]



Soil quality of a region is visualized with geo-reference using GIS techniques. Soil quality indicators which are estimated after sample collected from the field. A comprehensive knowledge is acquired when all the soil quality indicators are put together. Land is categorized based on the soil quality and management strategies are panned accordingly (Fig. 4).

2. **Simulation modeling:** A **computer simulation**, a **computer model** is a computer program, or network of computers, that attempts to simulate an abstract model of a particular system. Computer simulations have become a useful part of mathematical modeling of many natural systems in physics (computational physics), astrophysics, chemistry and biology, human systems in economics, psychology, social science, and engineering. Simulations can be used to explore and gain new insights into new technology, and to estimate the performance of systems too complex for analytical solutions.

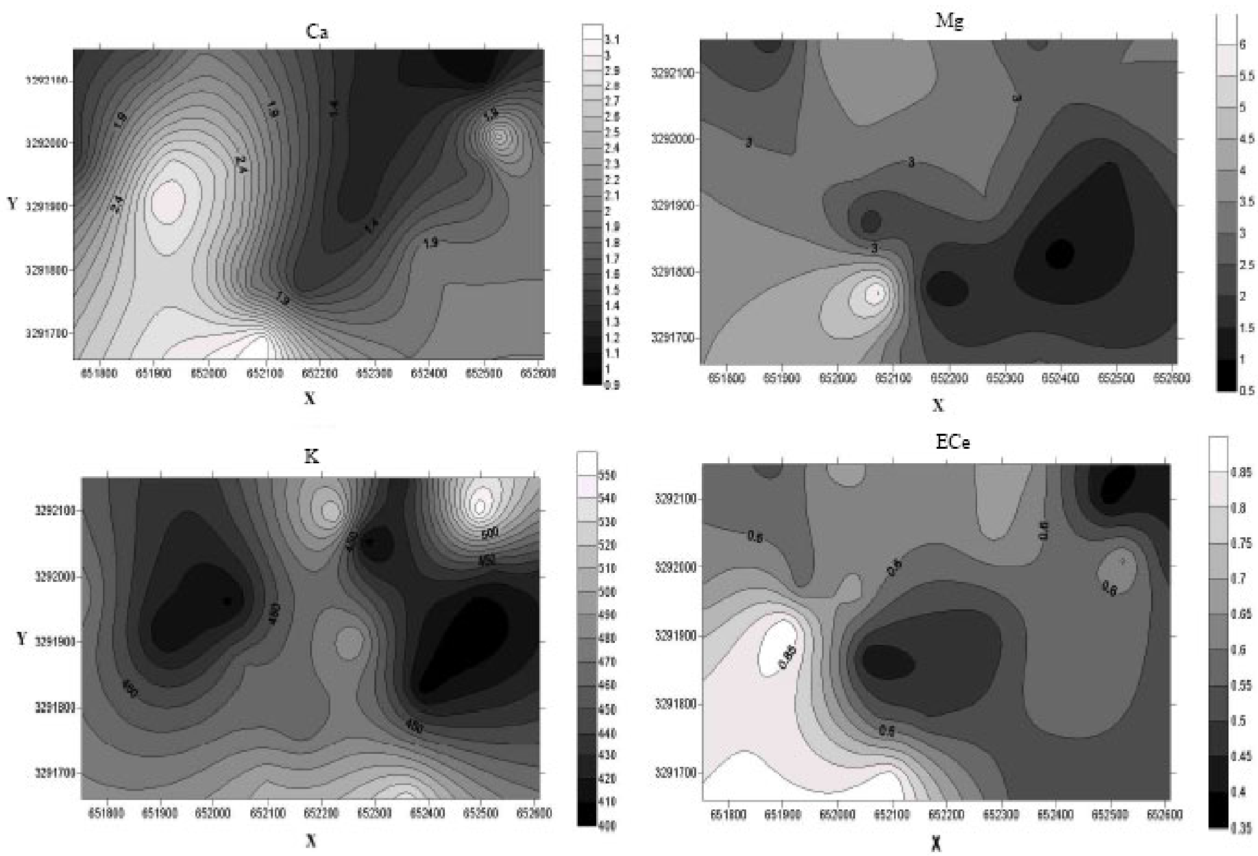


Fig. 5 Variation in soil quality drawn by krigging

Unknown values of soil quality parameters are estimated with known values. Linear models are employed to predict the values in inaccessible areas or other than the measured areas in the girds. Interpolation is done to get the values in all the unmeasured areas like Krigging techniques (Fig. 5) Soil quality is assessed exactly in each point and the contour maps are drawn. These developed maps are highly helpful for soil management such as irrigation, site specific nutrient management etc.

3. **Neural networks:** An artificial neural network is a system based on the operation of biological neural networks, in other words, is an emulation of biological neural system. Although computing these days is truly advanced, there are certain tasks that a program made for a common microprocessor is unable to perform. Artificial neural networks

(ANN) are among the newest signal-processing technologies in the engineer's toolbox. The field is highly interdisciplinary, but our approach will restrict the view to the engineering perspective. In engineering, neural networks serve two important functions: as pattern classifiers and as nonlinear adaptive filters. We will provide a brief overview of the theory, learning rules, and applications of the most important neural network models. Definitions and Style of Computation An Artificial Neural Network is an adaptive, most often nonlinear system that learns to perform a function (an input/output map) from data. Adaptive means that the system parameters are changed during operation, normally called the training phase. After the training phase the Artificial Neural Network parameters are fixed and the system is deployed to solve the problem at hand (the testing phase). The Artificial Neural Network is built with a systematic step-by-step procedure to optimize a performance criterion or to follow some implicit internal constraint, which is commonly referred to as the learning rule . The input/output training data are fundamental in neural network technology, because they convey the necessary information to "discover" the optimal operating point. The nonlinear nature of the neural network processing elements (PEs) provides the system with lots of flexibility to achieve practically any desired input/output map, i.e., some Artificial Neural Networks are universal mappers .

4.

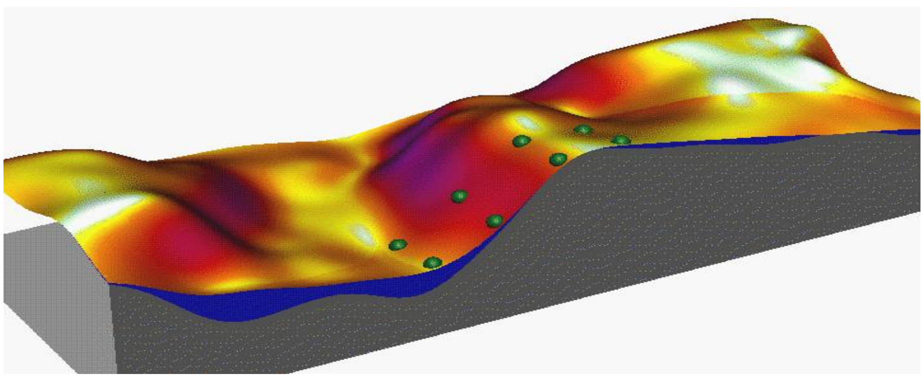


Fig. 6. Three dimensional map based on soil quality data showing variations

Neural networks is also simulation models and working on non-linear models. Based on the measured values the values are predicted in the unmeasured spots and contours are drawn. Elevation maps are also created to show the difference in soil quality parameters (Fig 6).

ICTs for Socio-economic upliftment of Rural Poor

R.K.P. Singh
Consultant (VDS)
National Centre for Agricultural Economics and Policy Research
DPS Marg, Pusa, New Delhi-110012

Information and communication technologies (ICTs) refer to technologies that provide access to information through telecommunication. It is similar to information technology (IT) but focuses primarily on communication technologies which include the internet, wireless networks, cell phone and other communication technologies have created a "global village" in which people can communicate with others across the world as if they were living next door. For this reason, ICTs after studied in the context of how modern communication technologies affect society.

There are several initiatives way in India to demonstrate the significant benefits of ICTs for rural populations. However, it is almost a paradox of introducing modern technologies before satisfying basic needs. The implementation or rural ICTs involves organizational and social change. Besides, an important barrier to realizing the economic benefits of ICTs is the often substantial high level of investment in new infrastructure – both hardware and software. In developed countries, large potential customer bases and efficient capital markets help overcome this barrier, hardware and software designed for developed countries can easily be adapted to serve higher income consumers in developing countries, but this leaves out the majority of the population in developing countries. In this scenario, one potential consequence of IT use is an increasing in equality as only higher income groups enjoy its benefit – this is the so called "Digital DEVIDE".

On the other hand, because government provide goods and services, including redistributive transfer payment, are often aimed at lower income groups, to the extent that ICT use can increase the efficiency and effectiveness of government, the benefits of IT will be more widely spread, partly reducing "digital devide" concerns. Private providers may therefore have also a role in delivering IT – based information services that are complementary to government services, as well as in providing conventional private goods and services. The lack of access to ICTs in developing countries means a growing knowledge gap is inevitable. Seventy percent of population in developed countries, in some countries close to 100% have access to the internet, while in close to 100 developing countries the figure is less than 10%. However about 7% population have access to internet connections in India in the year 2010. There has been sharp increase in internet users in India from only 14 lack in 1998 to 7 crore in 2010.

The Indian telecommunication industry is the world's fastest growing telephone (landlines and mobile) subscribers and 670.60 million mobile phone connection in Aug. 2010. It is the second largest telecommunication network in the word in terms of number of wireless connection after china. In India, government initiatives in this area include Bhoomi in Karnataka, e–seva in Andhra Pradesh, Lokmitra in Rajasthan and the like. Government of Bihar has also planned to establish e-Bhawan in each block to provide internet facilities to farmers. The ICTs are expected to exert positive inference on Education, Health, Employment and Agriculture which will have impact on

Socio-economic aspects of rural poverty. Information and communication technologies (ICTs) are crucial in improving access to health and education services and creating new sources of income and employment for the poor section of society. Being able to access and use ICTs has become a major factor in driving competitiveness, economic growth and social development. In particular, mobile phones are opening up new channel for connectivity and contributing to the free flow of ideas and opinions.

Education

Resources for rural education in India are limited and generally not used efficiently. Due to this factor there has been an over centralized system with poor incentive for delivery or education. ICTs can help decentralization through the use of rural ICTs kiosks. Operators who can act as teachers for smaller educational modules. The role of ICT kiosks is complementary to that of conventional schooling, as well as acting as a substitute. Since there are rural deficits in all the key components of education – teachers, textbooks and interaction digital material ICT – based interaction can ameliorate some of these deficits. ICT based rural education may have a significant role to play in adult education, ranging from basic literacy to very specific skills for those who have received a conventional school education. The Indian educational system has no. sound institutional mechanism for adult education. ICT – based rural education can fill many different gaps in the existing educational system in developing countries such as India. The advantages of an ICT – based approach are its flexibility and lower cost, assuming that the fixed infrastructure cost can be spread over a range of services. However, complementary institutional reforms are essential, and ICT – tools obviously cannot, by themselves, remove all of the education deficits faced by poor countries. Greater use of ICTs in schools can help achieve development goal related to universal primary education and the elimination of gender inequality in education. But there is a doubt on affordability of ICTs use to other educational need, particularly in Bihar context. There has been a tendency to oversell the benefits of ICTs for education; in reality, the evidence base is still sparse. The knowledge maps of education published by info Dev. were rather alarming in exposing how little is still known to date and provable about direct benefits.

There is a lack of complementation capacity as well as infrastructure for both powers supply and ICTs. General equity is also generally lacking. By contrast, developed countries form a more cohesive region in terms of understanding trends. ICTs are perceived as a way of efficiency change. The focus is on ICT Skill development. There is a regional ICT exam. and broadband is typically rolled out to schools without additional costs. A study finds a link between frequency of use of computers at home and improved student performance. However, socio – economic status of student must have some bearing on computer use and performance. There is a gap between the lives of students at home and in school.

ICTs and Health

Health and nutrition stand with basic education as the two most glaring failures of Indian since independence. The problems with public health care delivery are similar to those with education. Insufficient funding, severely compounded by ineffective institutions and incentives. For example, absenteeism in rural public health facilities is extremely high (Chandury et.al.). In a detailed survey in rural Rajasthan, Banerjee, Dealton and Duto (2004) found that health outcomes were poorly run and offered limited accessibility, which villagers often went to unqualified private practitioners, and they did not have good information about qualified practitioners for better quality health care and outcomes.

The role of ICTs in this situation can be multidimensional. One obvious possibility is the provision of basic medical information on line or on CDs. The benefits of this will be limited by the ability of rural population to absorb such information and act on it. It is important for basic medical information to be made available in local languages, but it is more likely that this would be a tool for rural medical practitioners, rather than something that can usefully be directed accessed by individual patient.

The kiosk based model in health has seen developed called Tele-DOC. The initiative used Java – enabled mobile telephones to provide rural health care workers with real Live, ability to record and transmit diagnostic information. The model involved Jiva,s panel of doctors analyzing this data, and then prescribing medicines and treatment. Medicines were compounded at a regional office, picked up by Tele-DOC field workers, and delivered to rural patients at their homes, at relatively low cost.

ICTs may also help improving rural health care in India through creation of database and geographical mapping of various health outcomes. This approach can also improve the targeting of rural health care delivery. While it does not solve the fundamental problems of incentives in field delivery of service, access to centralized health information data base may enable field providers to improve the quality and targeting of care. It is urgently needed to improve the availability and quality of health – related information in India through the use of ICTs. Rural ICTs kiosks are just one part of what is needed, but they can offer low cost access to health information for population.

ICTs and Agriculture

In development countries, farmers are using internet to get information about crop management, prices, e. commerce, and govt. programmers. Farmers will also be able to access current weather information and forecasts. Govt. of Nepal in PPP mode launched a portal – e.Haat – Bazar which promotes market linkages and enables Nepali growers and producers to explore opportunities within and beyond Nepal. The initiative is linked to www.agripricenepal.com, a website which provides daily agricultural market price information to farmers, traders and the wider business community. Similar initiates have been taken in China (Farmers Home), Bangladesh (www.ruralinfobd.com), Thailand (www.gotoknow.org),

Components of good governance are public sector management, accountability, legal and regulatory frameworks, transparency and information, human right, participatory approaches and military expenditure. I would like to discuss three important measures mentioned above, transparency in information, participatory approaches and human rights. All the three are inter dependent.

The real challenge is to develop better measurement. Students in developed countries are already exposed to information – rich environment and therefore improvement coming from use of ICTs in schools are likely to be marginal. One might expect a bigger impact in developing countries. A particular challenge is to understand how computers are used in school. For the most part, they seem to be aimed at developing ICT skills rather than using ICT as a medium for improving learning in other subjects.

Agriculture is the main sector of Indian economy since it contributes about one – fifth to national gross domestic product and provides employment to more than 50% of working force. Socio – economic status moves to the tune of agricultural development. There are several evidences of faster agricultural development through ICTs. In India, agriculturally developed states have comparatively large ICT network than agriculturally undeveloped states. Information can be provided for better input use, cropping decisions, management of pest and diseases, animal husbandry, and marketing.

Initiatives like Drishtee in Madhyapradesh, Aksh in Rajasthan, n–Logne in Tamilnadu e- chanpul of ITC in central India, TARA haat in U. P., Akshaya in Kerala are active in transferring agricultural and non-agricultural information for accelerating agriculture development and improving socio- economic status of farming community.

In the context of ongoing various agricultural development programmes, farmers are likely to become more exposed to the vagaries of global markets, empowering then with information access which may improve the reality of decision-making quality in more complex environments.Knowledge of more varied products would be particularly important in this context. Knowledge of new practices, especially emergency practices such as accelerated ripening techniques, rapid decision in case of untimely rains, and packing methods can be critical for mitigating risks with high value commercial crops serving distant markets. Beyond giving farmers more and better information, their choice sets can also be expanded: the ICT infrastructure delivering information may be used to bring down the cost as delivery of credit and crop insurance to farmers.

Reference:

Chandhury, Nazmul, Jeffrey Hammer, Michael k rearer, Kartik Murlidharan and Halsay Rogers (2006), Missing in Action; teachers and heath care providers absence in Developing countries, Development (PTO) research Group, world Bank, Journal of economic perspectives 20,1,91 – 116.

Banerjee, Abhijit V., Shown Cole, Esther Dutto, and Leigh linden (2005), Remedying Education; Evidence from two Randomized Experiments is in India, Development if Economics and Poverty Action Lab, Masscchustts Institute of technology, USA.

Annexure-I

List of State Level Trainees

Sl. No.	Name	Post	Institute / Division	District
1	**Sh. Sanjay Kumar**	District Dairy Development officer	Dairy	Siwan
2	**Sh. Ashok Kumar**	District Dairy Development officer	Dairy	Jamui
3	**Sh. Mithilesh Kr. Jha**	Dy. Agricultural Director	Agricultural	Darbhanga
4	**Sh. Arun Kumar**	Dy. Agricultural Director	Agricultural	Gaya
5	**Sh. Milan Rai**	Dy. Agricultural Director	Agricultural	Darbhanga
6	**Sh. Avinash Kumar**	Dy. Agricultural Director	Agricultural	Gaya
7	**Sh. Chandrabhushan**	Technical Officer, Div. of socio-economic, extension & training	Transfer of technology	Patna
8	**Sh. Devendra Nayak**	District Fishery Officer cum Chief Executive Officer	Fisheries	Katihar
9	**Sh. Krishna Kumar Sinha**	District Fishery Officer cum Chief Executive Officer	Fisheries	Saharsa
10	**Sh. Subodh Kumar**	District Fishery Officer cum Chief Executive Officer	Fisheries	Sitamarhi
11	**Sh. Dilip Kumar Singh**	District Fishery Officer cum Chief Executive Officer	Fisheries	Khagaria
12	**Sh. Vinod Kumar**	District Fishery Officer cum Chief Executive Officer	Fisheries	Kaimour
13	**Sh. Suresh Sinha**	District Dairy Development officer	Dairy	Saran, Chhapra
14	**Sh. Baliram Kumar Sinha**	District Dairy Development officer	Dairy	Purnia
15	**Sh. Arvind Sharma**	Dy. Agricultural Director (Extension)	Agricultural	Patna
16	**Sh. Bharat Prasad Singh**	Assistant Director (Survey) Cum Officer In Charge	RKVY, Patna	Patna
17	**Dr. Santosh Kumar**	Scientist (Plant Production)	ICAR-RCER, Patna	Patna
18	**Er. P. K. Sundaram**	Scientist (Ag. Engg.) Div. of LMP	ICAR-RCER, Patna	Patna
19	**Sh. Sanjay Rajput**	Technical Officer, Div. of socio-economic, extension & training	Transfer of technology , ICAR-RCER, Patna	Patna
20	**Sh. V. K. Tiwari**	Technical Officer, Div. of socio-economic, extension & training	Transfer of technology , ICAR-RCER, Patna	Patna
21	**Sh. Sushil Kumar**	District Fishery Officer-cum- Chief Executive Officer	Fisheries Division	Araria

For further details contact:

Director

ICAR Research Complex for Eastern Region, Patna, Bihar
ICAR Parisar (P.O.: BVC) Patna-800 014 (Bihar) India
www.icarrcer.res.in