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An Overview on ICT for Indian Agricultural Informatics Developments

Dr. Deshmukh Nilesh Kailasrao
School of Computational Sciences,
Swami Ramanand Teerth Marathwada University,
Nanded, (MH), India.

Abstract— **We aim to focus on key factors discovered for effective utilization of Information Communication Technology for agricultural boost up, at least on the surface, with supportive of evidence herein. Some issues discussed concern with how information technologies contribute to the wide sphere of agricultural and rural developments, as they are two sides of a coin .We have briefly surveyed several initiatives taken to provide IT- ICT based services in Asian region. Finally, we have suggested that there is a broad range of services that can be provided to a cross-section of rural households, particularly farmers even at relatively low levels of income to foster the developments in Asian zone.**

Keywords— **ICT, Agricultural Developments.**

I. INTRODUCTION

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 (IT) 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. E-Agriculture is one of the action lines identified in the declaration and plan of action of the World Summit on the Information Society (WSIS). The "Tunis Agenda for the Information Society," published on 18 November 2005, emphasizes the leading facilitating roles that UN agencies need to play in the implementation of the Geneva Plan of Action. The Food and Agriculture Organization of the United Nations (FAO) has been assigned the responsibility of organizing activities related to the action line under C.7 ICT Applications on E-Agriculture.

We have analyzed that [1, 2] the Information Technology and Information Communication Technology (ICT) can doubtlessly contribute much to agriculture development. Usually, people in agricultural business mainly from rural area, work as primary producers and have their own information needs. They need to know about marketing activities at districts levels, availability of natural resources around them, seasons and monsoons, market rates of different commodities, time to time government regulations, etc. Some advantages of it can include,

A. It can initiate new agricultural and rural business such as e-commerce, real estate business for satellite offices, rural tourism, and virtual corporation of small-scale farms.

B. It can support policy-making and evaluation on optimal farm production, disaster management, agro-environmental resource management etc., using tools such as geographic information systems (GIS).

C. It can improve farm management and farming technologies by efficient farm management, risk management, effective information or knowledge transfer etc., realizing competitive and sustainable farming with safe products. For example, farmer has to make critical decisions such as what to plant? When to plant?, how to manage pests?, while considering off-farm factors such as environmental impacts, market access, and industry standards. IT-based decision support system (DSS) can surely help their decisions.

D. It can provide systems and tools to secure food traceability and reliability that has been an emerging issue concerning farm products since serious contamination such as chicken flu was detected.

E. It can facilitate rural activities and provide more comfortable and safe rural life with equivalent services to those in the urban areas, such as provision of distance education, telemedicine, remote public services, remote entertainment etc.

II. FOCUS OF AGRICULTURAL INFORMATICS DEVELOPMENT

1. Improving Information Access and Delivery of Services for sustainable agricultural growth and livelihood
2. Adopting Global best practices
3. Empowering Farming Community & other Stakeholders
4. Promoting Informatics led Resource Planning and Management at grassroot level
5. Strengthening Research and Education, Training, Extension and Development linkages
6. Achieving Agriculture Online

III. ICT APPLICATIONS IN AGRICULTURAL DEVELOPMENTS: WORLD'S PRESPECTIVE

In the context of agriculture, the potential of information communication technology (ICT) can be assessed broadly under two heads: (a) as a tool for direct contribution to agricultural productivity and (b) as an indirect tool for empowering farmers to take informed and quality decisions which will have positive impact on the way agriculture and allied activities are conducted [2]. Precision farming, popular in developed countries, extensively uses IT to make direct contribution to agricultural productivity. The techniques like Remote Sensing using Satellite Technologies, Geographical Information Systems, Agronomy and Soil Sciences are used to increase the agricultural output. These approaches are capital intensive and useful where large tracts of land are involved. Consequently it is more suitable for farming taken up on corporate lines. Many Far East Asian countries like Japan, Korea, and China have practically implemented IT- ICT based development campaign for agriculture and rural development .To develop agriculture information systems, digital data contents are most important. Due to internet, fundamental and widely used data such as market information, weather information, and agricultural material information is becoming available. Taking in to mind the relevance between above lines, some efforts are made for such developments. We mainly appreciate Japan's imitative for such boosting. In past years , many Agricultural scientists have studied impact of Information Communication Technology on Agricultural [8,9,10,11]and one extremely lucid study done by Seishi Ninomiya , National Agricultural Research center , Tsukuba, Japan , is a must read [4] . This work mainly highlights the key factors therein [4] for analogous Indian developments.

The indirect benefits of IT in empowering Indian farmer are significant and remain to be exploited. The Indian farmer urgently requires timely and reliable sources of information inputs for taking decisions. At present, the farmer depends on trickling down of decision inputs from conventional sources which are slow and unreliable. The changing environment faced by Indian farmers makes information not merely useful, but necessary to remain competitive In addition to human economic activities, Agriculture stands on the very complex interaction between biological, climatic and geographical factors. The information flow under such complicated system is unpredictable, unstable, subjective, site-specific and reliant on empirical decisions given the inherent variability of biological phenomena. Agricultural information with these features is typically beyond the scope of the information science used in industrial information systems, and this has surely led to the failure, up to some extent. We have discovered basic problems Indian farmers are facing and attempted to solve them using ICT related approaches.

Problem 1: Conveying Field Information like Crop Yield and Quality

India is basically a large country and major population live in villages, geographically scattered. Although agriculturally sound, Indian farmers are not using trends in Telecommunication industry as modern ways to communicate field information. This often results for farmers to take many efforts to convince Merchants about their crop yield, crop quality so as to get best bid price. We suggest that, instead of remaining stuck to traditional sources acquiring crop information, the advances in computer technology (ICT) can help miraculously. A modern and state of the art system is found functional in Far East countries which use a web camera mounted on a metrological robot to record farm-working activities [8]. The web camera automatically collects crop images used to remotely analyze plant growth and condition. A recent mobile phone version of it collects field data today [4]. Many people [6] tried to effectively use web based framework for the same. For example, Personal Digital Assistant-PDA-based field data collection systems combined with GPS (Global Positioning System) which record farming data on PDAs combined with location information of the plot. We have also found that some steps have been taken to synchronize such data with PCs. A proposal [4] meritoriously used voice-recognition technologies to record farming data directly from the fields. Another proposal [6] developed a field monitoring system called Field Server. A Field Sever originally has ordinal sensors such as temperature, solar radiation, moisture and soil temperature. It has very flexible interface and can optionally have several types of sensor such as a web camera, an infrared sensor, wind speed, wind direction and leaf wetness. In addition to its sensing functions, Field Server can serve as a wireless LAN access point so that each Field Sever can establish a wireless network with other Field Servers. This indicates that a whole region can be covered by the Internet accessible wireless Hot spot, having several Field Servers deployed and just one link point to the Internet in the region .Latest version of the Field Server is completely autonomous without any requirement for electric supply. A new approach called case-based modeling has also been suggested recently. To model some phenomena such as crop growth, we usually take either mechanistic modeling or statistical modeling. Case-base modeling is partially close to statistical modeling but it is not always based on probability as statistical modeling does. A case-base is a kind of database

that stores empirical cases and has a function to recommend relevant cases according to users' decision making queries. A prototype case base system developed using a concept search engine that is based on latent semantic indexing. User can enter normal sentences as queries to the system and the system searches for recommended cases corresponding to the queries. This is a typical non-reductive approach and seems to be a very powerful way to transfer knowledge for farm decision support.

Problem 2: Effectively Displaying Field Information

Since major Indian agricultural population resides in rural places, it is observed that the designing of easy-to-use interface is a big challenge. Such interfaces are extremely needed to display the farm information collected in problem 1.Several technologies have found available to provide easy-to-use systems for end users. For example, mobile phone-based interface is surely promising. Its simple screen is usually acceptable. The second and third generation mobile phones provide seamless connectivity to the Internet and can substitute for regular PCs. Actually, mobile phones are used not only for data collection but also for in situ decision support in the fields. For example, [4, 9] developed mobile-phone based applications to access weather database so that farmers can always check weather conditions in their fields. Geographical Information System (GIS) technology [10] is also promising in agriculture especially as a user interface to integrate several types of data sets. As agricultural information typically extends spatially and it is often necessary and convenient to handle it at a regional scale, an application of GIS to agricultural decision support is developed [4]. The system predicts the benefit to a farmer and the environmental stress based on the various scenarios about crop conversion planned by the user, integrating many layers of geographical data such as soil conditions and the watershed. Fulcher's group [4] in Japan also provides several Web-based GIS systems to the public, indicating the importance of sharing Internet-based resources such as huge data sets and expensive GIS systems. Once datasets and some analytical methods become available, GIS can be a powerful tool/interface for agricultural and rural DSS.

Problem 3: Knowledge Discovery from the Collected Information

In recent years computer scientist devoted their research studies to data mining and pattern matching areas. These both are related to each other and mainly stand for discovering hidden rules / knowledge from the collected information. Using ICT services, we can collect the agricultural data across the world and that too of past several years. This will potential construct a large data warehouse which could give us new knowledge in agricultural production. By discovering hidden patterns, we could even forecast climatic changes, demand, production estimate, increase in demand, etc valuable factors [7]. Data mining is familiar with statistical reasoning and also aids to display data in graphical format. However the crucial information on agriculture is still in the custody of Governmental agencies and we need to professionally organize them. Similarly there is an extreme need to digitize those data for an agricultural information system.

Problem 4: Changing Market Places

Since technology has been assimilated into developments, there is an extreme need to change appearance of traditional market places. Internet used in developed countries suggests that information exchange related to the completion of market transactions is especially valuable. In the rural Indian context, farmers selling their crops and buying inputs, parents seeking matrimonial alliances for their children, and job seekers are all potential users of Internet-based services. This facilitated IT based businesses in agriculture. Web-based marketing was originally initiated as a direct marketing system between farmers and consumers. This style of business called B2C. It has been steadily growing with the growth of Internet technology. Internet malls that virtually combine several farmers growing various commodities seem to be particularly promising, though have not yet achieved critical mass. Recently, a new style of business called B2B has been growing rapidly. This bridges farmers and wholesalers, substituting for fresh markets by providing virtual market places over the Internet. In Japan, farmers found started a very interesting trial. They are equipping their greenhouse with a web camera system [4, 6] in order to analyze the growth of the crops. They utilized this system for their sales promotion. They sold plantlets of melons to consumers and undertook the management of those until harvest. While the plants were growing, they let the consumers to access web camera to observe the growth of plants. This idea was popular with urban people, giving them a virtual experience of farming.

Problem 5: Extending Cooperation: Virtual Farming

Due to exponential growth in Indian population, the land available for farming is reducing in size as it is continuously getting divided generation by generation. This is called as Small-scale farming and is typical in the Asian region. It is also a cause of the inefficient agricultural productivity and lack of global competitiveness. A simple solution is to merge small-scale lands to a big scale one. The land ownership, however, makes it difficult as the number of landowning farmers increased in recent time, may be due to the modernization in living style. One solution we can expect is to virtually integrate those small-scale farmers while keeping their financial independency. For example, a group of farmers can purchase chemicals with cheaper price than they can individually. Similarly they can share machineries and the total cost on them can be reduced. We can expect similar cost reduction in marketing, logistics, risk management etc. as merits of scale. To realize such cooperation, the help of IT is inevitable in many ways.

IV. OUTCOMES OF USE OF ICT IN AGRICULTUR

- Development of Databases and Information Systems for providing online services and information access services for the above

proposed services and dissemination of information through Portal
- Empowerment of Stakeholders (Government Officials, Research, Education & Extension Scientists, farmers and other service providers such as Community Information centers.
- Human Resource, Financial Resource and Asset Management Information system
- Development of Knowledge Management, Decision Support and Advisory Systems to strengthen Extension services
- Development of Farmers Redressal system
- Creation of Content on Portal
- Creation of ICT Infrastructure to provide services to farming community
- Development of Databases and Information Systems for providing online services and information access services for the above proposed services and dissemination of information through Portal
- Empowerment of Stakeholders (Government Officials, Research, Education & Extension Scientists, farmers and other service providers such as Community Information centers.
- Human Resource, Financial Resource and Asset Management Information system
- Development of Knowledge Management, Decision Support and Advisory Systems to strengthen Extension services
- Development of Farmers Redressal system
- Creation of Content on Portal
- Creation of ICT Infrastructure to provide services to farming community
- Improved information access and delivery of services to the farming community.
- Establishing Agriculture online
- Efficient and improved communication system among all the offices of the department of Agriculture in the state through the use of e-mails services.
- Improved transparency and accountability of the Department.
- Direct feedback from farming community to the decision makers in the state.
- Better monitoring of government schemes, which directly impact the farmers.
- Efficient management (Development, Conservation, allocation and utilization) of resources
- Improved productivity and profitability of farmers through better advisory systems.
- Efficient & Increased utilization of information by stakeholders for their decisionmaking.
- Faster and efficient Redressal of farmer's grievances.
- Foundation for development of e-business in agriculture
- Better organizational efficiency and productivity

V. ICT APPLICATIONS IN AGRICULTURAL DEVELOPMENTS: INDIAN STORY

Today we witnessed two types of potential economic gains of ICT in India, the Static and the Dynamic. Former is one-time, and come from more efficient use of scarce resources, allowing higher consumption in the present. The later pertains to increases in operating efficiency, and aims for reduced transaction costs. For example Information technology based machines at milk collection centers are being used in cooperatives to measure butterfat content of milk, test the quality of milk, and make prompt payments to farmers. "This has resulted in the removal of incentives to cut the milk by adding water, reduced time for payments from 10 days to less than five minutes, and has thus instilled confidence in farmers in the cooperative set up."

How beautifully the Information and Communications Technology (ICT) can be used as an effective tool for rural development can be seen "Warana, Wired Village" project, in the state of Maharashtra, India [1,2]. Here, the local cooperatives are using ICT to streamline the operations connected with sugar cane growing and harvesting. This is benefiting small farmers, in terms of transparency, time saved in administrative transactions, and in terms of monetary gains. This project was initiated in 1998 .The stated goal of the project is not only to increase the efficiency and productivity of the sugar cane co-operative, but also to provide a wide range of information and services to 70 villages around Warana river belt . The project has already increased the efficiency of the sugar cane growing and harvesting process. Due Internet facility, the farmers are now accessing information on agricultural techniques, innovations, as well as on crop prices. Similar gain is also seen in E-Choupal scheme where it provides farmer an access to local market ("Mandi ") prices and global market price for Soybean crops and derivative products so that the farmers can compare prices. The Warana example suggests four key lessons on the use of ICT for agricultural development in India: (1) Before launching any ICT initiative, the information needs of a community should be thoroughly assessed. (2)Content and software applications should be developed with continuous involvement and feedback from the community. (3)Special emphasis should be placed on women and poor people's access and (4) Operators from the grassroots are probably the best agents to bring ICT to rural communities.

VI. CONCLUSION

This paper has examined efforts taken by major developed countries in order to sketch the wide canvas of ICT for agricultural developments. This is then thought in the lines for the potential benefit of Indian agricultural developments in particular and rural developments in general. We have

observed that several initiatives have already been taken by Far East Asian countries and they need to be just tuned with Indian scenario. The study of literature related to ICT based agriculture development has indicated various issues impeding success of such initiatives. The main issues in India are lack of localization of content for rural communities and inadequate participation of rural communities in design of rural ICT initiatives.

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