



EMERGING ROLE OF ICT IN INDIAN AGRICULTURE

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ABSTRACT

India's agriculture sector continues to be the lifeline of its people and a key factor in the economy's overall productivity. Agriculture is an important part of India's economy and at present it is among the top two farm producers in the world. This sector provides approximately 52 percent of the total number of jobs available in India and contributes around 17.32 percent to the GDP. Agriculture is the only means of living for almost two-thirds of the employed class in India. This paper analyses the dynamics of digital transformation of the Indian agricultural system and major drivers of transformation, giving an overview of the past achievements and the future challenges in Indian agriculture to be strategically dealt with to accelerate sustainable broad-based growth in the agriculture sector in the country.

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INTRODUCTION

With the growing advances in technology the information and communication facilities has emerged as a boon to the finance sector. The information and communication technology (ICT) is now at present forming a base for all the activities undergoing under the finance sector of all types of organization. Starting from the maintenance of the records of the organization till providing the goods and services to the consumers ICT has a role to play. Information and communication technology (ICT) has a critical role to play in development efforts around the world. There was a time when the benefits of applying ICT in fighting poverty and promoting economic growth were not widely understood. Many in the development community questioned how high-tech (and often expensive) communication technology could be used to alleviate such dire challenges as starvation, homelessness, and lack of basic education and health services. Lately, however, this view has given way to an understanding of ICT as an essential component of broader efforts to harness the free flow of information to increase voice, accountability, and economic development. In the past few decades, information and communication technology (ICT) has transformed the world.

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It's potential for reducing poverty and fostering growth in developing countries has increased rapidly. Mobile telephones provide market links for farmers and entrepreneurs. The Internet delivers vital knowledge to schools and hospitals. Computers improve public and private services, and increase productivity and participation. The ICT has also contributed towards the Indian agricultural activities. By connecting people and places, ICT has played a vital role in national, regional, and global development, and holds enormous promise for the future.

Agriculture and its role in India

India is principally an agricultural country. The agriculture sector accounts for about 18.0% of the GDP and employs 52% of the total workforce. India is the world's largest producer of pulses, rice, wheat, spices and spice products. India has many areas to choose for business such as dairy, meat, poultry, fisheries and food grains etc. India has emerged as the second largest producer of fruits and vegetables in the world. India remains among main three as far as production of different agricultural things like paddy, wheat, pulses, groundnut, rapeseeds, natural products, vegetables, sugarcane, tea, jute, cotton, tobacco leaves and so on. On the other hand, on advertising front, Indian agribusiness is as yet confronting the issues, for example, low level of business sector reconciliation

and integration, availability of dependable and convenient information needed by farmers on different issues in farming. India is divided into 16 agro-climatic zones, 10 vegetative zones and 15 biotic provinces. Rice cultivation in India covers nearly 22% of agricultural area, which is followed by wheat (13%), oilseeds (15%), pulses (13%), commercial crops (8 %) and horticultural crops (29%) (Directory of Indian Agriculture, 1997). Indian is an agriculture based country, where more than 50% of population is depend on agriculture. This structures the main source of income. The commitment of agribusiness in the national income in India is all the more, subsequently, it is said that agriculture in India is a backbone for Indian Economy. The contribution of agriculture in the initial two decades towards the total national output is between 48% and 60%. The aggregate Share of Agriculture and Allied Sectors, Including agribusiness, domesticated animals, and ranger service and fishery sub segments as far as rate of GDP is 17.32 percent during 2017-2018 at 2004-05 prices. Agricultural exports constitute a fifth of the total exports of the country.

Role of Agriculture in Growth

Two reasons why agriculture is considered central to growth:

- It has a big share of GDP,
- It stimulates —structural transformation—the process whereby resources move from low productivity sectors to higher productivity sectors.

Two possibilities for structural transformation:

- It can be driven by productivity improvements within the agricultural sector
- It can be driven by productivity improvement outside the agriculture sector

Role of agriculture in Indian economy

- Share in National Income
- Largest Employment Providing Sector
- Contribution to Capital formation
- Providing Raw Material to industries
- Market for Industrial Products

Importance in International Trade

- Share in national income
- Source of employment
- Provision of food grains
- Supply of raw materials to industrial sector
- Market for industrial product
- Earner of foreign exchange

Indian agriculture before ICT

Crop cultivation is a complex process and involves a set of activities like land preparation, planting, pest control, irrigation, nutrient management, harvesting, marketing, etc. The entire cycle of crop production requires multitude of information by the farmers. Large sections of the farming community, particularly the rural folk, do not have access to the huge knowledge base acquired by agricultural universities, extension-centers and businesses. The Indian farmers were basically lacking the knowledge and information which are of

immense help for the decision making regarding the cultivation and earning their livelihood. Before the introduction and adoption of ICT in agriculture the following were the major issues and challenges faced by the Indian farmers:

Information on past trends: Information on past trends regarding area, production, productivity, consumption, utilization, pest attack, climatic conditions, environmental concerns, fertigation, etc are of immense use in making decision in crop production. For example, past trends in climatic conditions may help growers in scheduling cultivation activities for optimum production and control of stresses.

Government decisions: Government decisions related to agriculture and its products marketing, labour laws, land holdings, rural development etc is also important factors while taking decision. All such information must reach to the farmers at the earliest, so that one may take right decision for high production and maximum return. The information about government policies and support facilities to the farmers in time will empower the farmers in the way to their prosperity.

Many unanswered questions: Farmers frequently seek information regarding various inputs needed in their field such as seed, fertilizers, pesticides, labour, transport, etc in terms of cost, quality, availability and possible sources. Once crop gets ready for harvesting, need arises for its marketing. The questions like; where to sale, when to sale, how to sale and whom to sale mesmerizes the farmers. At this point of time, information provision related to marketing and transportation is must, which may help farmers in decision-making of agriculture product marketing. In this respect the main challenge for the farmers was to find this knowledge and apply it to the decision making process involved in agriculture development. The solution for this problem was to recognize, locate and utilize this specialized knowledge; currently embedded in organizational databases, processes and routines as a distinct factor of production to increase productivity and competitiveness. ICT became one of the tools for achieving the capabilities mentioned above to enable the farmers to remain competitive in this fast changing world.

Indian agriculture after ICT

With the adoption of ICT in the Indian agriculture sector, the activities of the farmers and their decision making has become much more simplified. The ICT is now playing a major role in the agricultural field and has also supported for a higher growth in the production and sale of the agricultural products.

Information and communications technologies are an important ingredient of virtually every successful knowledge management program. Sadaan [2001] has identified five essential categories of technology requirement in agricultural research and development for knowledge management viz. business intelligence, collaboration, knowledge transfer, knowledge discovery and expertise location. A variety of ICT tools are available for knowledge management in agriculture. An effective knowledge management in crop production and protection will involve an integrated approach of various ICT tools and techniques.

Database & Data Warehouse: Database and data warehouse technologies [Chaudhari et al. 2001; Hipsley, 1996; Humpshires, 1999; Ralph, 1998] are used to store and retrieve

large amount of data (both text and image) efficiently at affordable cost. Temporal / historical data on crop production, protection and utilization statistics, meteorological facts and pest / disease survey data and other useful data may be managed using these repositories for further analysis and decision support.

Data Mining, OLAP and analytical techniques: Data Mining and OLAP techniques [Ganti et al. 1999; Humpshires, 1999; Monte, 2001; Ralph, 1998] make it possible to extract new finding and meaningful patterns from large historical database. Based on these analytical techniques useful advices can be developed for farmers.

Expert System: An Expert System is an intelligent computer program that uses knowledge and inference procedures to solve problems that are difficult enough to require significant human expertise for their solution. Expert in crop production and protection are the modern extension tools for decision support at farmer level. It can suggest suitable variety, method of field preparation & sowing, irrigation, fertilizer application, etc. Disorder diagnosis and treatment are one of oldest application of expert system.

GIS / GPS: A geographic information system (GIS) integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information. GIS allows us to view, understand, question, interpret, and visualize data in many ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts. Major application of GIS in agriculture includes land use analysis, thematic mapping, demographic analysis, socio-economic studies and environment management.

Internet / Intranet: Internet technology [Agarwal, 1999; Bennett, 1996] has revolutionized the world of information communication. With this the information dissemination to farming community can be made instantaneously in parallel. Further this technology provides a powerful collaboration mechanism for knowledge sharing using WWW, Email, Chatting, News Group, etc.

Simulation and Modeling: Modeling and simulation technology can be used to model an ideal crop situation and predict its growth through extrapolation and other techniques by considering a specific crop environment. Crop Simulation Models [Singh, 1994] can be developed for environmental characterization, optimizing crop management, pest / disease management, impact study of climate change, yield forecasting, effective crop scheduling, etc.

Multimedia Tools: Multimedia means many media – text, video, narrated sound, music, graphics, animations, special effects, etc. which are controlled, coordinated and integrated by a computer. Multimedia is simply multiple forms of media integrated together. Multimedia based Instructional Tools, Encyclopedia, Tutorials, Videos, etc not only give enhancement over text only messages but also improves understanding and retention of information.

Challenges faced and opportunities encashed

Challenges faced

Access to IT: In the case of ICT, access to the technology means an individual must have access to equipment. The

category “access to IT” would not only include the use of a computer with IT ability, but would also include the ability to upgrade computer hardware and software to facilitate IT use. The price of needed computer equipment and the expense of Internet use are also related to access to IT. It is predicted that the higher the level of access to IT, the higher the level of IT use by an individual.

Demographic: The demographic category includes adoption factors such as age, education level, gender, and income level. It is hypothesized that factors in the demographic category will not significantly influence IT adoption and use. IT use will be higher for younger, more educated individuals, 1997 survey results suggest that demographic factors have little influence on IT adoption and use. This may reflect that demographic factors may influence the decision to adopt a new technology, but once that decision to adopt is made, demographic factors may have little influence on use.

IT Training/Education: Another category of ICT factors is IT training/knowledge. This IT adoption factor can be measured with variables such as type of IT training, days of IT training, and the level of knowledge on IT use. It is hypothesized that as the quality and level of IT training increases, the use of IT will also likely increase.

Perception: An important factor influencing the adoption of any new technology is an individual’s perception of that technology. It is hypothesized by this research that one of the key perception aspects influencing the adoption of IT is the level of trust that the potential adopter has in the IT system and in those who use IT. Trust can be defined as “an individual’s optimistic expectation about the outcome of an event”. There are different aspects of trust related to IT.

Inadequate ICT Facilities and Personnel: Singh et al. (2014) reported some existing issues to include inadequate accessibility of ICT services to rural farmers, lack of basic skills of using ICT facilities in agriculture, inability of government to deliver adequate ICT knowledge to farmers. On the other hand, a study by Agu (2013), specifically focuses on the problems faced by women in agriculture like access to land, access/weak extension services, access to credit, lack of supportive policies, access/no adoption of new agricultural technologies, and restricted access to training and education. These issues continue to persist because information that could help the farmers adjust and minimize their problems were either absent or not sufficient.

Introducing a new technology to farmers poses obstacles. Other adoption and dissemination difficulties usually encountered are listed below:

- Not all farmers are interested in a computerized managerial information system. Some are satisfied with cost accounting at seasons’ end, sometimes not even that.
- Some of the farmers use other software packages, including Excel spreadsheets or dedicated software which may or may not be adequate.
- Personal impediments of various kinds.
- Personal preferences. There are farmers who tried ICT and decided to quit because they did not find it user-friendly enough, special needs were not met, etc.
- Dissatisfied farmers will discourage others from using ICT, even after installation.

- Marketing of ICT to farmers is non-existent.
- Awareness of managerial information systems benefits is limited, resulting in situations where they have yet to be internalized.
- Experience shows that farmers unassociated with the extension service are left behind professionally, which includes the use of ICT

Opportunities encashed

An increased need for information: Agricultural production is in the process of constant structural adaptation dictated by deteriorating terms of trade and characterized by larger, commercialized production units (Ministry of Agriculture and Rural Development, 1999). The larger the production unit and crop diversity the larger the need for more sophisticated data management and support for decision making.

Prevalence and simplicity: The prevalence of computers is consistently increasing which in turn reduces reluctance to adopt them. Eventually reduced inhibition and lower costs lead farmers to seek and adopt software to suit their needs. The less sophisticated farmers tend in time to join the process by seeking suitable simple, non-challenging solutions.

Returns on investment: Farmers that found ICT to be beneficial and compatible with their needs pointed out the following advantages: easy collection of data, favorable comparisons of cost and income, follow-up of data input, establishment of cumulative data sets, their use and information accessing all translating into management efficiency.

Maintaining existing competencies: An adopter's level of education and training correlates positively with the ability to manage information, production processes and attain benefit from adopting a new technology (Gelb, 1998). It stands to reason as well that an adopter's level of education correlates positively with the level of benefit accrued to adoption of the managerial information systems. ICT enables even the most conservative farm managers to utilize the system for supporting decisions without a threat of unfamiliar changes in management procedures.

Flexibility: ICT is not confined to a specific crop or crop-pattern which in turn allows the farmer maximum adaptation flexibility. Consequently, different farmers growing the same crop may utilize the program differently. Experience indicates that in many cases dedicated programs, attempting to be all-inclusive become inflexible, and eventually irrelevant.

On time Information: When information is unavailable when needed on time at a decision point, the decision is taken based on a currently different situation. This can distort the managerial processes. ICT enables accessing data and information when needed. This is due to the simplicity of entering data as well as extracting reports.

Strategize Market Activity: The use of ICT enables entrepreneurs to access relevant and recent business information. This provides likelihoods for younger generation-agro based entrepreneurs to established their own network and websites regardless of time and place. Consequently, they could advertise their products both in national and international markets. Likewise, ICT solves issues such as

traceability, process control, transparency in market information, reduction in transaction costs, and identification as well as tracking of consumer needs. This result is in accordance with Bhalekar et. al., (2015) that ICT could be used to secure food traceability and reliability that has been an emerging issue concerning farm product like chicken flu and other related diseases. Besides, new agricultural and rural business such as e-commerce, real estate business for satellite offices, rural tourism, and virtual cooperation of small scale farms are initiated.

Improves Economic Growth: Information and Communication Technology tools could be adopted in the Agricultural sector to accelerate the development and may automatically lead to growth in national economy (Pande and Deshmukh, 2015). This implies that application of ICT in agriculture may enhance national economic growth by facilitating farming activities within required period.

Research in Agriculture: The significant of ICT in agricultural research is quite enormous. It supports policy and decision making with the use of GIS such as disaster management and agro environmental resource management. Furthermore, it could ease rural activities and provide effective and safe rural life such as provision of distance learning, telemedicine and remote public service.

Future prospect of ICT in Indian agriculture: The USDA Forest Service and Environmental Protection Agency have cooperatively developed a knowledge base for assessment and monitoring of ecological states and processes in sixth-code watersheds. The knowledge base provides a formal logical specification for evaluating watershed processes, patterns, general effects of human influence, and specific effects on salmon habitat. The system integrates geographic information system and knowledge base system technologies to provide an analytical tool for environmental assessment and monitoring. The basic objective is to improve the quality and completeness of environmental assessments and the efficiency with which they are performed.

Farm Net is a network of rural people and supporting intermediary organizations, such as extension services, using ICTs and conventional communication media to facilitate the generating, gathering and exchanging of knowledge and information. Operated by farmers and their organizations, Farm Net farmers to each other and to the resources and services that they need to improve their livelihoods through agricultural productivity, profitability and food security.

aAQUA is an online multilingual, multimedia Agricultural portal for disseminating information from and to the grassroots of the Indian agricultural community. aAQUA simultaneously addresses two major challenges in farmer outreach programs - geographic reach and customized delivery. It answers farmers queries based on the location, season, crop and other information provided by farmers. Agricultural content repositories (Digital Library), Agri-price information (Bhav Puchiye), farmer schemes and various operations support databases (aAQUA-QoS) have also emerged from the experience of aAQUA deployments. aAQUA's large scale deployment provides avenues for researchers to contribute in the areas of knowledge management, cross-lingual information retrieval, and providing accessible content for rural populations [Ramamritham, 2006].

Wen [2007] presents a knowledge-based intelligent e-commerce system for selling agricultural products. The KIES system not only provides agricultural products sales, financial analysis and sales forecasting, but also provides feasible solutions or actions based on the results of rule-based reasoning. The intelligent system integrates a database, a rule base and a model base to create a tool of which managers can use to deal with decision-making problems via the Internet. For offering convenient delivery and user-friendly services to customers, an e-map combined with a GPS is used.

LPCUBE Wise Agri KM™ is an innovative knowledge management solution designed for the agriculture industry. It enriches research and helps researchers to share knowledge and reuse the lessons learned. The collective knowledge base built using this platform can be used to disseminate right knowledge to the farmers at the right time. It enriches farming and ultimately improves agriculture productivity.

Agricultural Information Management Standards (AIMS), website <http://www.fao.org/aims/index.jsp>, is a portal whose main objectives are: to facilitate collaboration, partnership and networking among partners by promoting information exchange and knowledge sharing; and to harmonize the decentralized efforts currently taking place in the development of methodologies, standards and applications for management of agricultural information systems; consequently, providing a 'one-stop' access to system designers and implementers.

Conclusion

The study outlined the critical roles of ICT in agricultural technology development in India centering on opportunities and challenges. The review mainly focuses on potential benefits and problems associated with the application of ICT in agriculture. This review has identified that agricultural research, improvement of market activity, exchange of relevant information, profit gain; networking agricultural activities globally, conducting research and strategizing economic growth for self-reliance are among the possible benefits of ICT. However, lack of basic ICT skills, absence of political will, in adequate and fluctuation of power supply, poor internet infrastructure, and insufficient personnel to handle ICT infrastructure, language and harmonization of knowledge continued to impede ICT implementation in agricultural growth.

Relevant suggestions were given by various researchers to overcome challenges militating against successful implementation of ICT in agricultural technology advancement but were found to be insufficient. Therefore, further research should focus on these challenges to bring out more suitable solutions.

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