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Information And Technology (ICTS) In Agriculture Value in India

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Abstract

Information and Communication Technology (ICT) has led to ease of operations in the value chain of the agriculture sector, where the number of actors in the value chain is holding it back in the realisation of its full potential. These inefficiencies arise due to the non-adoption of technology in certain stages of the value chain. This issue of inefficiencies can be resolved with the help of an end-to-end solution in the total supply chain. Certain recent initiatives of the government and the private sector in India towards using Information and Communication Technologies (ICTs) in terms of market information, input availability, and post-harvest management like geotagging of Agri warehouses, reefer vehicles and cold storages are a step in the right direction.

Further, to address the issue of access to these technologies by smallholders, certain innovative pilot projects are being developed. Non-profit as well as private sector initiatives in this space are also highly encouraging. An attempt has been made in this paper, to evaluate opportunities and constraints associated with the use of ICT to enhance the productivity of agriculture and associated sectors in India.

Introduction

The Indian agriculture sector (US$ 370 billion) plays a vital role in the Indian economy. The country's total geographical area is 328.7 million hectares with a cropping intensity of 143.6 per cent. India has 15 agro-climatic regions and 46 types of soil. India ranks first in India ranks first in terms of production of spices, pulses, milk, tea, cashew, and jute, and stands second in the production of wheat, rice, fruits and vegetables, sugarcane, cotton, and oilseeds. Further, India is the second largest producer of fruits and vegetables and is the largest producer of mango and banana. The contribution to GDP by the agriculture sector is likely to be 19.9 per cent in 2020-21,

increasing from 17.8 per cent recorded in 2019-20 (Economic Survey 2020-21).

The government has taken many initiatives to aid and enhance the agriculture sector with proven farming technologies and supportive policies. The evolution in digital technology for farming will further accelerate growth by ensuring higher crop yields. It will also help to enhance sustainability by reducing water consumption and the use of agrochemicals (Goutam, 2014).

Conflict Of Interest in Agricultural Marketing

The farmers always expect higher production and maximum price for their harvest. On the other hand, the traders, retailers and manufacturers expect to get high quality raw material at a low purchase price with a higher margin. The consumers desire to get good quality and fresh produce at a reasonable price at their doorstep. This conflict of interest of different players in the agricultural value chain is a result of the fragmented supply chain prevalent in Indian agriculture. There are two ways to overcome this problem

Firstly, all the supply chain activities have to be

brought under a single umbrella and second, we need to take the help of the advent of ICT to design an end-to-end solution. Against this backdrop, an attempt has been made in this paper to analyse various initiatives of ICTs in agriculture in general and Agricultural Marketing in particular (Chatarjee & Kapur, 2016).

Characteristics Of Conventional Marketing System

In the conventional agricultural marketing system, farmers prefer to sell their commodities at the village level. Around 80-90 per cent of perishable commodities, 40-80 per cent of cash crops and 20-60 per cent of food grains are sold in the local markets. The main reasons for this distress sale are indebtedness, inadequate transport, small surplus, inefficient supply chain, perishability of produce, information gap, etc. It is essential for farmers to know the market and accordingly plan their produce and then grow it. The trend has been shifting now from production led to market-led extension.

Integration Of Agricultural Production and Marketing

It is vital to integrate the production and marketing activities for agricultural produce. There is a need to disseminate knowledge on basic dimensions of agricultural marketing viz., market-oriented production planning, and preparation of produce for marketing, storage/preservation techniques, infrastructure and transport facilities, market information and integration of marketing networks. Market oriented production planning like what to grow, when, where and how to grow is very essential at the farmers' end, followed by preparation of the produce for marketing, through grading sorting, packaging and labelling which has to be done to secure the maximum price. The next step is storage/preservation techniques, to add value to the produce, after which it is essential to ensure infrastructure and transport facilities to reduce the post-harvest losses.

Additionally, the use of market information in terms of arrivals and prices and integration of marketing networks like direct sale, wholesalers etc., is necessary to secure better prices by farmers (Darekar & Gummagolmath, 2021).

Need For the Study

ICT based initiatives are using different technologies, but with a limited reach to the intended stakeholders. This limited reach is mainly on account of tele-infrastructure, lack of awareness, literacy level and information needs of the farmers. However, in the recent past, the predominance of tele-infrastructure, availability of internet facilities and advent of social media has minimized inefficiencies in the value chain of agriculture. However, the reach of ICT to all the stakeholders is a far cry.

Hence, it is essential to analyze the extent of the reach of both public and private ICT initiatives in agriculture.

Digitalization Of Agriculture

Over the years, the government has taken major steps to aid and enhance the agriculture sector with proven farming technologies and supportive policies. The recent evolution of digital technology in farming will further accelerate growth by ensuring higher crop yields and enhance sustainability by reducing water consumption and the use of agrochemicals. Digital technologies, such as the Internet of Things (IoT), Machine Learning (ML), Artificial Intelligence (AI), Remote Sensing, Big Data and Blockchain are modernizing operations and transforming the entire agricultural value chains. Although several countries, such as the USA, Netherlands, Israel and Australia have successfully adopted digital solutions to revolutionise agriculture, their adoption in India is still in a nascent stage. The future adoption of digital agriculture in India is anticipated to nurture under the Public-Private Partnership (PPP) mode.

Information And Communication Technologies (ICTS)

Information and Communication Technologies (ICTs) is an umbrella term that includes any communication device or application, encompassing: radio, television, mobile phones, computers and network hardware and software, satellite systems and so on, as well as the various services and applications associated with them, such as video-conferencing and distance learning.

ICT is simply an electronic means of capturing, processing, storing and disseminating information. It comprises those networks, mobiles, devices, services, and applications that aid the processing, management, and exchange of data, information, or knowledge with a target audience. They include a broad range of converging technologies, including traditional telecommunications, television and video, radio, CDROMs, cell phones and smart devices, and several modern technologies such as computers and the internet, sensors, Geographic Information Systems, satellites, and the like. Essentially, the purpose of ICT is to transfer information from one point to another (Adhiguru & Devi, 2012).

Why ICT

ICTs have largely revolutionised the way people, governments, and businesses, both large and small, function in the modern world. Close to 60 per cent of the global population has access to the internet, and mobile internet is now the most widely-used channel for internet access worldwide. The tremendous adoption of ICTs has made it possible to facilitate better communication and ensure the delivery of services and information to people who previously lacked access. The infusion of new, advanced technologies has allowed the global agriculture sector to surge ahead and transform the way producers cultivate, harvest, and distribute agricultural commodities. The use of ICT in agriculture, or e-agriculture, has accelerated agricultural and rural development by adopting innovative ways to improve the existing information and communication processes.

It has particularly revolutionised smallholder agriculture in several agrarian economies and has helped address several challenges associated with the traditional form of agriculture. ICTs are meeting information, communication, and knowledge needs of farmers, agribusinesses, governments, and society through different features like e-collaboration, distance neutral, interactive, mobility, market transparency etc. (Deshmukh and Patil, 2021).

What ICT Can Deliver

ICT has many potential applications in delivering agricultural extension and can bring new information services to rural areas by reaching every corner of the country. All stakeholders of the agriculture industry need information and knowledge and ICT can play a significant role by creating an interface for the farmers to the outside world.

The collaborative business modules can offer entrepreneurship opportunities and also deliver information regarding the prices of commodities in various mandis (agricultural markets). ICTs are cost effective and ensure timely as well as accurate information dissemination amongst the stakeholders.

ICTs can also be linked with other governance services to be delivered in rural areas.

The list of few successful ICT initiatives in India is given below.

Table 1: Successful ICT Initiatives in India

Initiative	Details
e-Extension (e- Soil Health card Programme)	Dept. of Agriculture, Gujarat State has one of the ambitious programmes which aims to analyze the soil of all the villages and provide guidance
AGRISNET	It uses state-of-the-art broadband satellite technology to establish the network within the country by MOA&FW. It is a comprehensive web portal, to broadcast relevant information to farmers, which was initiated and funded by the Ministry of Agriculture, Government of India. The AGRISNET serves farming community by disseminating information and providing services through use of ICT.
AGMARKNET 2000	A comprehensive database which links together all the important agricultural produce markets in the country for dissemination of market information by DMI. It aims in empowering decision-making ability of the farmers regarding selling of their produce. This portal was developed to pace up the agricultural marketing system through broadcasting information about influx of agricultural commodities. the market and their prices to producers, consumers, traders, and policy makers transparently and quickly.

Kisan Call Centres (KCC) 2004	KCCs were commenced by the Department of Agriculture and Co-operation with the main intent of delivering extension services to the farming community in the local languages. The queries of farmers are answered by agricultural graduates on help line, toll free number in their local language. The agricultural scientists also visit the field in person to get an idea about complex agricultural problems to resolve them. It is delivering extension services to the farming community
Tata Kisan Kendra	This private initiative by TATA chemicals ltd. started with an objective of providing the farms with infrastructure support, operational support, controlling farm activities etc. with the advent of ICT.
e-Choupal	This is ITC's Agri Business Model, a conglomerate, to link directly with rural farmers via the Internet for procurement of agricultural and aquaculture products like soybeans, wheat, coffee, and prawns.
AKASGANGA (Meaning "milky way" in Hindi)	It demonstrates the potential of information technology to impact livelihoods in poor, rural communities. This ICT project makes possible milk collection, fat testing, and payment in a timely and user-friendly manner. It augments the income generation of dairy farmers through incorporation of advanced technology.
Global Positioning System (GPS)	A satellite-based navigation system that can be used to locate positions anywhere on the earth
Remote sensing (RS)	It is the science of making inferences about material objects from measurements, made at distance
Geographic Information System (GIS)	It is a technological tool that analyses and presents information tied to a spatial location
ICTs in Weather Forecasting	These disseminate meteorological information and weather warning, climate change
Digital green	It is an international organization, which works with a participatory approach by engaging the rural community to improve their livelihood using a digital platform. Interactive and self-explanatory videos are prepared for farmers by progressive farmers with the assistance of experts. These videos are shown to the farmers at individual level or in groups. The videos are prepared keeping in view the requirements and welfare of the rural masses.
Warana (1998)	The Warana "Wired Village" project was initiated with the objective of providing agricultural information and services to farmers for increasing productivity. The information about prices of agricultural outputs, employment schemes of the government of Maharashtra and educational opportunities is transmitted to the farmers in the local language. The information is disseminated through information kiosks with the help of operators, who are the main linkage between the farmers and the agricultural experts.

IFFCO KISAN SANCHAR LTD (IFFCO Kisan) (2012)	It delivers relevant information and custom-made solutions to the concerned farmers through voice messages on mobile phones. The farmers can also communicate directly to the agricultural experts on explicit themes via 'phonein' programmes.
Digital Mandi	It is an electronic trading platform for facilitating farmers and traders to sell and procure agricultural produce beyond the geographical and temporal limitations effortlessly. Various financial institutions also participate in online trading of agricultural output to remove cash crisis.
eArik (2007)	It aims to disseminate climate smart agricultural practices and to achieve food security. It is an integrated platform to enhance the accessibility of agricultural information and technology in north-eastern India. It delivers agricultural specialist advice on crop cultivation, crop management and marketing. Farmers can also obtain information directly from the portal but field workers.
aAQUA (Almost All Questions Answered)	It is a multilingual online system that facilitates farmers by advising them, solving their problems and answering their questions related to agriculture. Farmers have to register on aAQUA platform online or telephonically. After that, they can post their queries on the portal, for which they get answers shortly.
Fisher Friend Mobile Advisory KCC	The Fisher Friend Programme (FFP) of M S Swaminathan Research Foundation was launched in 2009 to protect fisher folk from occupational hazards and to empower their livelihoods. The relevant information on wave height, wind speed and direction, potential fishing zones, relevant news, government schemes and market price is provided to fishermen in the local language. The FFP covers marginalized coastal communities in Tamil Nadu, Puducherry, Andhra Pradesh, Kerala, and Odisha, and is operational in English, Tamil, Telugu, Malayalam, Odiya languages.
Reuters Market Light (RML) (2007)	It was initiated to deliver customized information to the registered farmers via mobile-SMS. It disseminates information in eight local languages in 13 states.
Village Knowledge Centers (VKCs) 1998	Village knowledge centres of MS Swaminathan research foundation were initiated in Pondichery as a gateway to technical information related to agricultural inputs, price of outputs, crop rotation, use of fertilizers and pesticides. Information is disseminated through public address system.

Importance Of Market Information

The market information about arrivals and prices of agricultural produce is very vital to the farmers for taking proper production and marketing decisions. Well-analysed historical market information enables farmers to allocate their resources among different crops in line with the urban consumer demand, including those related to new crops and regulate the flow of produce to markets. The traders can rationally take a call on when and where to buy and sell, plan for transport, storage etc.

Essentials Of Market Information and Flows

Market information can be regarded as a public good, particularly where there are a number of small farmers who are unable to pay for information. The availability of timely, analysed,

accurate and applicable information to all interested parties is therefore essential, irrespective of source. The need to provide up-to-date price information is particularly essential in the case of perishable produce and where price fluctuations are frequent. Many countries have attempted to provide market information at the national level, but their success rate has been poor. Market Information Services have repeatedly proven to be unsustainable and where they have endured, they have often failed to provide commercially useful advice, confining themselves to the gathering of, frequently unused, data.

Table 2: Current Initiatives Under Digital Agriculture in India

Year	Initiative
September 2021	Govt of India announced the initiation of the Digital Agriculture Mission 2021-2025, while signing five Memorandum of Understanding (MoUs) with Jio Platforms Limited, Ninjacart, CISCO, ITC Limited and NCDEX e-Markets Limited (NeML), to take forward digital agriculture through pilot projects. It aims to support and accelerate projects based on new technologies, like blockchain, AI.
June 2021	An MoU with Microsoft to run a pilot programme for 100 villages in 6 states. Under the MoU, Microsoft is expected to create a 'Unified Farmer Services Interface'
Mar 2021	ITC has proposed to create a personalized 'Site Specific Crop Advisory' service to turn conventional crop-level generic advice into a personalised site-specific crop advisory for farmers, using a digital crop monitoring platform, hosted on ITC's e-Choupal 4.0 digital platform. The pilot project will be at Sehore and Vidisha (Madhya Pradesh).
February 2020	The Jio Agri (JioKrishi) platform launched, digitises the agricultural ecosystem along the entire value chain to empower farmers. The advanced functions use data from various sources, feed the data into AI/ML algorithms and provide accurate personalised advice. The pilot project will take place at Jalna and Nashik (Maharashtra).
August 2019	An Agricultural Digital Infrastructure (ADI) solution developed by CISCO to enhance farming and knowledge sharing. It is likely to play a vital role in the data pool that will be created by the Department of Agriculture under the National Agri Stack. The pilot project will take place Morena (Madhya Pradesh) and Kaithal (Haryana).

April 2016	National Agriculture Market (eNAM) is a pan-India electronic trading portal that links the existing Agricultural Produce Market Committee (APMC) mandis, to create a unified national market for agricultural commodities. eNAM helps farmers sell products without the interference of any brokers or mediators, by generating competitive returns from their investment
January 2013	Direct Benefit Transfer (DBT) Central Agri Portal is a unified central portal for agricultural schemes across the country. The portal helps farmers adopt modern farm machineries through government subsidie.

Need Of the Hour

Agriculture is facing new challenges but the stakeholders involved in the agriculture sector are yet to benefit from ICT. There are different tools to access essential information regarding quality seeds, agriculture finance, irrigation, livestock care and market prices. The service providers shall also charge for value-added premium services for demand driven information instead of offering it free. The collaborative business modules over the single supplier, multimedia supported information than text services and cost-effective innovative solutions would have added benefits than costly technology. The need of the hour is to use modern media over traditional media and share localized and crop specific information than the generic one.

Driving Forces in ICT Market Integration

Many a time the government policies and frameworks are one of the driving forces behind digitalization as it creates an enabling environment for competitive digital markets and e-services. The use of social media, rapid technological advances, the discovery of new sources of competitive advantages, the pursuit of first mover advantages, need for real time engagement and need for value chain coordination are the driving forces behind the ICT market integration.

Product & Service Transformations

Digital platforms are new economic institutions functioning in a new reality characterized by being transaction intermediaries while giving rise to new economic ecosystems and new value creation logic. A fragmented digital agriculture ecosystem has been linked to the slow scale-out of digital platforms and other digital technology solutions for agriculture. The agribusiness products and services can be transformed by creating e-value through automation of farm production, access to market information services, food supply chain traceability and customization of e-agriculture services (Saravanan & Darekar, 2020).

Impact Of ICT In Agriculture

The effective distribution of ICT can increase agricultural attractiveness by reducing transaction costs, raising production, efficiencies and farmers' incomes, by providing more information and value to stakeholders. In recent years, information and communication technologies have been introduced in agriculture projects and have provided fruitful results in rural and agriculture development (Meena & Singh, 2012).

For instance, information and communication technologies can be used for distance learning programs and help the farmer in learning about new approaches and technologies for agricultural development in developing countries. Such technologies can provide information on weather, prices, and profitable income.

ICT offers the opportunity to enhance smallholder marketing in the following ways. It is evident that those farmers who have used the information and communication technologies in agriculture have increased their production information and knowledge. Similarly for those who have used the e-services, e-commerce applications also increased their income. ICT has its impact at the household as well as the national level.

ICT has helped in resolving market failure and given access to food and financial markets. The new early warning systems have helped climate

change management. Due to income growth, food access, food security improvements have been witnessed. ICTs have helped in alleviating rural poverty, developed knowledge and improved value chain performance through regional/global market integration (Satapathy, 2015).

- Better production management and data analytics: ICT solutions are providing better farm management and data analytics solutions to improve marketing capabilities. Farmers can take informed decisions and plan their production accordingly.
- Finding Buyers/Market: Identifying additional buyers and having multiple buyers available is advantageous with the help of ICT.
- Using market information for sales planning: There are dozens of ICT solutions to deliver market information to small farmers, which helps in planning resources as well as sales.
- Better traceability: Commercial buyers like wholesalers and exporters find it challenging to source from smallholders, as the quality and safety standards are often compromised. ICT offers a solution through complete traceability and blockchain technology.

Suggestions For Effective ICT Application

Many stakeholders who are part of the agri value chain are already using ICT to streamline and enhance their marketing functions, ranging from using social networks to complex customer management tools (Jensen, 2007). A few suggestions for effective application of ICT are -

- Ease of access to Portals - consumer friendly
- Up-to-date content and coverage
- Layout design and consistent themes
- Easy navigation and higher interactivity
- Access through multiple media
- Higher use of non-textual information
- Multiple local/vernacular language
- Low cost of transactions

Executive Summary

The modernization of India's agricultural sector is currently driven by the Digital Agriculture Mission (DAM), a comprehensive umbrella scheme approved in September 2024 with a financial outlay of Rs. 2,817 Crore. This mission aims to replicate the success of India's broader digital revolution by creating a robust Digital Public Infrastructure (DPI) for the agrarian economy. Central to this transformation are the AgriStack and the Krishi Decision Support System (DSS), which together aim to provide digital identities to 11 crore farmers and integrate geospatial data for real-time decision-making.

Agri Stack: The "Farmer ID" Ecosystem

Agri Stack serves as a farmer-centric DPI to simplify the delivery of government schemes. It comprises:

- **Farmers' Registry:** Providing a "Farmer ID" (similar to Aadhaar) as a trusted digital identity.
- **Geo-referenced Village Maps:** Linking land records to digital identities.
- **Crop Sown Registry:** Tracking real-time agricultural data.

Krishi Decision Support System (DSS)

The DSS integrates remote sensing data regarding crops, soil, weather, and water resources into a unified geospatial system. A critical component is Soil Profile Mapping, aiming to map 142 million hectares of agricultural land at a 1:10,000 scale.

Precision Farming: Concepts And Methodology

Precision Farming (PF) is defined as an information- and technology-based farm management system used to identify, analyze, and manage spatial and temporal variability within fields.

1. **Right Source:** Identifying and addressing limiting nutrients with correct chemical or organic sources.
2. **Right Place:** Using grid soil sampling and site-specific management zones to quantify variability.
3. **Right Time:** Utilizing active remote sensors for real-time canopy mapping and fertilizer application.
4. **Right Amount:** Applying nutrients based on algorithms developed by research institutions.
5. **Right Manner:** Choosing the

ICT Interventions And Market Reforms

The "Open-Source Simple Computer for Agriculture in Rural Areas" (OSCAR) developed a weed identification system (IDAO) for the Indo-Gangetic Plains.

- **Key Insight:** Researchers found that while the tool was effective for identification, farmers prioritized weed control and management over identification. This highlights the need for ICT tools to address immediate livelihood concerns and social contexts,

such as indebtedness and input availability.

National Agriculture Market (E-NAM)
The e-NAM scheme promotes integrated markets across India to handle market inefficiencies.

- **Impact:** Evidence from Rajasthan indicates that adoption of e-trading through e-NAM has led to increased price realization for farmers and higher market arrivals, signifying improved market development and competitiveness.

Government Initiatives and Financial Outlays
The Indian government has launched several schemes to incentivize the adoption of high-tech agriculture:

Scheme	Objective	Financial Details / Assistance
DAM (2024)	Umbrella digital mission	Rs. 2,817 Cr (Central share: Rs. 1,940 Cr)
PMKSY - Per Drop More Crop	Expand micro-irrigation (Drip/Sprinkler)	55% subsidy for small/marginal farmers; 45% for others
National Horticulture Mission (NHM)	Integrated development of horticulture	85% GOI share; 15% State share; 50% subsidy for greenhouses
Micro Irrigation Fund (MIF)	Resource mobilization via NABARD	Rs. 5,000 Cr corpus; 3% lower interest rate for states

Additional Specialized Allocations (2024):

- **Crop Science:** Rs. 3,979 Cr for food security and climate resilience.
- **Agricultural Education:** Rs. 2,291 Cr for management and social sciences.
- **Livestock Health:** Rs. 1,702 Cr to boost dairy and livestock income.
- **Krishi Vigyan Kendra:** Rs. 1,202 Cr for local agricultural extension centers.

Socio-Economic Impact
The transition to digital agriculture is projected to have significant employment benefits:

- **Job Creation:** The mission is expected to create opportunities for approximately 2,50,000 trained local youth and Krishi Sakhis (agricultural companions) to assist in grassroots implementation.
- **Transparency:** Digital authentication for services reduces paperwork, physical visits, and corruption in the distribution of crop insurance and loans.
- **Disaster Response:** Digital crop maps allow for faster insurance claims and more accurate disaster response monitoring.

Research Methodology
This research project concludes its findings majorly on the basis of secondary data which is supported by primary research conducted in area called Karhal, District- Mainpuri, Uttar Pradesh. Research methodology helps in identifying the problem, collecting and analyzing the required data and providing an appropriate solution to the problem. Both quantitative and qualitative methods were used for conducting the study. Data collection methods included questionnaires for farmers. All data gathered during the study was analyzed using descriptive statistical method.

Conclusion And Way Ahead
Agriculture contributes significantly to the Indian economy. ICT can revolutionize agriculture in many ways. ICT projects are yet to make any breakthrough in agricultural information dissemination and other areas. Deployment of ICTs needs to be stressed more. ICT for agricultural projects needs to be compared and evaluated precisely.
Robust and economical mobile infrastructure is imperative for the exchange of vital information between farmers and service providers. Further, the use of smartphones and tabs for information dissemination is more efficient and tailored for the users as it facilitates in installing software applications for getting advanced risk mitigating strategies such as early warnings and advisory information.
It also helps in integrating the supply chain with GPS which provides mapping functionality.
Thus, ICT innovation empowers farmers by facilitating timely access to localised and personalised information for greater control of their production, risks and thus market their

produce to the identified market opportunities.
It is the need of the hour to obtain apposite information through ICTs and to deploy advanced ICTs in agriculture, one of the indispensable sectors in our country. It is a well-known fact that ICT can revolutionize agriculture in many ways.
There is a need to strengthen the physical infrastructure (storage, logistics), regulatory mechanisms (APMC Act, agri input/marketing licenses); and socioeconomic conditions (financial inclusion, aggregation).
A professionally managed ICT platform can bring the various pieces of the agri value chain together and act as a catalyst for agricultural growth. The solutions must be mobile based approach to maximize onground adoption and impact.
Effective use of social media in Supply Chain Management is necessary for the benefit of all stakeholders. The high potential for ICT integration in agribusiness value chains must be tapped.

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