

Digitalization in Indian agriculture:

Reorienting Indian farming towards smart agriculture

R Roy Burman*, Girijesh Singh Mahra, Sushmita Saini, S K Jha and U S Gautam

Indian Council of Agricultural Research, Krishi Anusandhan Bhawan I, Pusa Campus, New Delhi 110 012

Information and Communication Technologies (ICTs) has proved to be extremely beneficial for farmers and helped them in getting easy access to customized digital information regarding improved varieties, cropping pattern, use of high-yielding seeds, fertilizer application, pest management, marketing, entrepreneurship etc. The most effective and widely used instrument for agriculture extension to share information and provide advice to farmers is the mobile phone. There are several important mobile apps developed by the Ministry of Agriculture and Farmers Welfare, Government of India and other organisations which are using Geographic Information System (GIS) and Data Analytics of Smart Agriculture to deliver accurate information to the farmers at their doorstep. IoT and AI offers wide range of applications in agriculture.

Keywords: Artificial intelligence, Digitalization, Information and communication technologies, Mobile apps

TIMELY access, affordability and efficiency of agricultural information is very crucial for raising agricultural productivity among especially in the developing countries. Digitalization through various ICT's can have a leading role in the dissemination of right information to needful farmers at right time. There have been some successful initiatives in India, where digitalization of agricultural information was attempted. In most of these projects, agriculture is only a small component. India has gathered successful and enriching experiences with several IT projects.

Mobile telephone is the most influential and omnipresent tool of agriculture extension to disseminate information and to give advisories to farmers. Push and Pull SMS, Interactive voice response system (IVRS), mKisan and Kisan Call Centres (KCC) are the mobile telephony initiatives to cater to the diverse need of farmers and information dissemination. To harness the potential of mobile telephony under National e-Governance Plan-Agriculture (NeGP-A), Ministry of Agriculture and Farmers Welfare has launched various modes of delivery of e-enabled services including mobile telephony.

Advances of digitalization in Indian agriculture

Mobile based apps

The number of mobile apps providing accurate and timely information to the agriculture sector is

increasing. Today mobile applications are available for smart agriculture zones, latest agriculture information like identification of pests and diseases, real-time data about weather, early warning about storms, best local market prices, seeds, fertilizers etc. information to farmers at their doorstep. There are several important mobile apps developed by the Ministry of Agriculture and Farmers Welfare, Government of India and other organisations which are using Geographic Information System (GIS) and Data Analytics of Smart Agriculture to deliver accurate information to the farmers at their doorstep. Some important and widely used mobile apps are as follows:

- **Kisan Suvidha:** It is an all-encompassing mobile app developed to help farmers by providing relevant information. App provides information to farmers about weather, market price, dealers, plant protection, IPM, seeds, expert advice, soil health card, godown and cold storage provides information.
- **Pusa Krishi:** This mobile app has been launched to take the technologies developed by the institute of Indian Agricultural Research Institute to the farmers' fields. It contains information related to new varieties of crops developed, detailed knowledge of agricultural machinery and its implementation and production technologies.
- **Soil Health Card Mobile App:** This application

provides easy access to the soil test reports given by the farmers to them. Using Smart Agriculture's global positioning technology, it captures the exact location and soil quality of the farmer's field.

- **Bhuvan Hailstorm App:** Through this mobile app, the data of damage caused to the farm due to hailstorm is recorded along with photographs and geographical location, which simplifies the process of giving insurance to the farmer by assessing the loss due to hailstorm. Data analytics of smart agriculture is used by this mobile.
- **e-NAM Mobile App:** The objective of the mobile app is to make available the crop price to the farmers and other stakeholders at the right time on their smart phones by the traders/mandis. In this, data analytics of smart agriculture has been used and the facility of bidding has also been given to the farmers.
- **Agri-Market Mobile App:** This app can be used by farmers on their mobile devices. To know the market price of the crops within 50 km. This app automatically captures the location of the person using the mobile and informs the farmer about the Global Positioning System (GPS) and price of the markets within 50 km.
- **RiceXpert:** This is an app developed by National Rice Research Institute, Cuttack in the year 2017. It has been developed to provide all the information related to rice like, rice varieties, nutrient availability, weed control, nematode management, pest infestation and control, disease related problems and prevention, crop management, agricultural monitoring available to reduce labor etc. has been given for different ecologies in the crop. Also, this app acts as a diagnostic tool for quick resolution in rice by answering questions, assessing the problem by picture and through voice.
- **Krishi Insecticide and Fungicide Calculator:** National Centre for Integrated Pest Management Research, New Delhi has developed insecticide and fungicide app on web and mobile platform for 12 major crops, viz. Rice, Cotton, Cabbage, Cauliflower, Brinjal, Arhar, Groundnut, Tomato, Soybean, Gram, Chilli, Okra. The main objective of these apps is to assist researchers, agricultural extension workers and farmers in the selection and use of pesticides with labels, judicious pesticide selection for the management of pests and diseases.
- **Fasal Salah:** It is an informative Mobile app which is designed to help farmers by providing real time personalized crop advisory based on current and forecast weather which includes Temperature, Humidity, Wind Speed and Direction, Rainfall for next 10 days at taluk and village level.
- **Krishi Yantra App:** Central Institute of Agricultural Engineering, Bhopal (ICAR-CIAE) under Indian Council of Agricultural Research (ICAR) has developed Krishi Yantra App to augment research, operations and technology dissemination process in the field of agricultural engineering. In order to ensure that appropriate mechanization technology

is selected by the entrepreneurs, a web-portal has been made available by ICAR-CIAE on their website. This helps prospective and existing entrepreneurs in selection of machines and available choices for procurement. Option of interaction between user and specialists is also available in the portal.

- **Farm mech App:** The App is related to decision support for selection of suitable farm machineries for five major crops of Tamil Nadu. It also has dynamic Networking of 2,250 Custom hiring service operators in Android platform.

Apart from this, many apps have also been developed by various government organizations, private companies, which use smart agricultural techniques to reach accurate information at the right time to the farmers like Solapur Pomegranate, Cane Advisor, Animal Nutrition, Agriculture Video Advice App etc. Understanding the importance of mobile app, Indian Council of Agricultural Research has also created a special mobile app gallery where detailed information and downloading link of 355 agriculture mobile apps are available (<https://krishi.icar.gov.in/mobileapp/>).

In addition to these initiatives, ICAR has launched KISAAN 2.0 (Krishi Integrated Solution for Agri Apps Navigation) which is envisaged to help e-agriculture and to drive smart phone-based agriculture in India. This app integrates more than 300 apps related to agriculture, developed by ICAR Institutes in an aggregator android mobile app. It has been developed with an aim to make farming convenient for Indian farmer. KISAAN 2.0 app provides a single interface in multiple Indian languages for Indian farmers to access agricultural knowledge about crops, horticulture, livestock, fisheries, natural resource management, agricultural engineering, agricultural education and agricultural extension. This app is going to revolutionize the way how an Indian farmer avails information on advanced agricultural technologies, seeds, varieties and livestock as per their requirement leveraging the accelerated Internet and smart phones penetration in our country.

Automation in Indian agriculture: Internet of Things (IoT), Artificial Intelligence (AI) and Blockchain technology

There has been a recent paradigm shift in engineering and technology due to emergence of three innovative technologies: AI, IoT and Blockchain. Next generation ICTs especially smart phones and apps, IoT, smart networks, big data analytics, AI and Blockchain have provided a new vision and aspect in the field of Agriculture. These have huge potential to increase the production and marketing processes.

Internet of Things (IoT): It is a system where each real-world entity is provided with unique identifiers and able to communicate over an Internet. The approach of using IoT technology to ensure optimum application of resources to achieve high crop yields and reduce operational costs is called precision agriculture. IoT in agriculture technologies comprise specialized equipment, wireless connectivity, software and IT services.

Artificial Intelligence (AI): It is based on the principle that human intelligence can be defined in a way that a machine can easily mimic it and execute tasks, from the simplest to those that are even more complex. IoT and AI offers wide range of applications in agriculture, some of which are mentioned as:

- **Precision farming:** This is one of the most famous applications of IoT in the agricultural sector. Many organisations are working in this area for instance, Crop Metrics is a precision agriculture organization focused on ultra-modern agronomic solutions while specializing in the management of precision irrigation. The products and services of Crop Metrics include Variable rate irrigation (VRI) optimization, soil moisture probes, virtual optimizer PRO, and so on. VRI optimization maximizes profitability on irrigated crop fields with topography or soil variability, improve yields, and increases water-use efficiency. The soil moisture probe technology provides complete in-season local agronomy support, and recommendations to optimize water-use efficiency.
- **Agricultural drones:** Ground-based and aerial-based drones are being used in agriculture in order to enhance various agricultural practices like crop health assessment, irrigation, crop monitoring, crop spraying, planting, and soil and field analysis. The major benefits of using drones include crop health imaging, integrated GIS mapping, ease of use, saves time, and the potential to increase yields.
- **Livestock tracking and geofencing:** Farm owners can utilize wireless IoT applications to collect data regarding the location, well-being, and health of their cattle. This information helps to prevent the spread of disease and also lowers labour costs. This information helps them in identifying animals that are sick so they can be separated from the herd, thereby preventing the spread of disease. It also lowers labour costs as ranchers can locate their cattle with the help of IoT based sensors.
- **Smart greenhouses:** A smart greenhouse designed with the help of IoT intelligently monitors as well as controls the climate, eliminating the need for manual intervention. For controlling the environment in a smart greenhouse, different sensors are installed that measure the environmental parameters according to the plant requirement are used. We can create a cloud server for remotely accessing the system when it is connected using IoT and eliminates the need for constant manual monitoring. Sensors can control the actuators automatically to open a window, turn on lights, control a heater, turn on a mister or turn on a fan, all controlled through a WiFi signal.
- **Predictive analytics for smart farming:** Crop predication plays a key role, it helps the farmer to decide future plan regarding the production of the crop, its storage, marketing techniques and risk management. To predict production rate of the crop, artificial network uses information collected by sensors from the farm which includes parameters

such as soil, temperature, pressure, rainfall, and humidity. The farmers can get an accurate soil data either by the dashboard or a customized mobile application.

- **Weather forecasting:** With the change in climatic condition and increasing pollution it's difficult for farmers to determine the right time for sowing seed, with help of Artificial Intelligence farmers can analyse weather conditions by using weather forecasting which helps them to plan the type of crop to be grown and when should seeds to be sown.
- **Soil and crop health monitoring system:** AI-based applications can identify the nutrient deficiencies in soil including plant pests and diseases by which farmers can also get an idea to use fertilizer which helps to improve harvest quality by using image recognition-based technology. Such type of app helps farmers to monitor soil and crop's health conditions and produce healthy crops with a higher level of productivity.

Blockchain technology: It is referred as a decentralized, distributed ledger that records the origins of a digital asset. The Blockchain is defined as a chain of Blocks that comprises information. Every block registers all the current transactions, and after completion stores into the Blockchain as a permanent database. Each time a block gets completed and a new block is created. The Blockchain technology offers following important applications in agriculture.

- **Efficient food supply chains:** The blockchain technology can track the provenance of food and thus helps create trustworthy food supply chains and build trust between producers and consumers. As a trusted way of storing data, it facilitates the use of data-driven technologies to make farming smarter. In addition, jointly used with smart contracts, it allows timely payments between stakeholders that can be triggered by data changes appearing in the blockchain.
- **Transparent transactions:** The blockchain technology allows peer-to-peer transactions to take place transparently and without the need for an intermediary like a bank (such as for cryptocurrencies) or a middleman in the agriculture sector. By eliminating the need for a central authority, the technology changes the way that trust is granted – instead of trusting an authority, trust is placed in cryptography and peer-to-peer architecture. It thus helps restore the trust between producers and consumers, which can reduce the transaction costs in the agri-food market.
- **Crop Insurance:** Blockchain can improve crop insurance scheme execution in two dimensions. First, payments can be made timely and automated based on weather data that triggers the payout as defined in a smart contract. Second, weather information and other data sources, such as plant growth information or data collected by farm machinery, can be automatically integrated via a

smart oracle improving basic risk reduction and making the index determination and payout process more efficient.

- **Data storage and management:** The blockchain technology serves to store data and information that various actors and stakeholders generate throughout the entire value-added process, from seed to sale, of producing an agricultural product. It ensures that the data and information are transparent to the involved actors and stakeholders and all recorded data are immutable. The database is incredibly helpful for developing data-driven mobile applications that help optimize farming.

New initiatives in digital agriculture

Indian government and many other organisations has taken following exclusive initiatives for promoting digitalization of agriculture in India

India Digital Ecosystem of Agriculture (IDEA) framework: Government has finalized an India Digital Ecosystem of Agriculture (IDEA) framework which would lay down the architecture for the federated farmers' database is being built by taking the publicly available data as existing in various schemes and linking them with the digitized land records. The IDEA would serve as a foundation to build innovative agri-focused solutions leveraging emerging technologies to contribute effectively in creating a better Ecosystem for Agriculture in India. This ecosystem shall help the Government in effective planning towards increasing the income of farmers in particular and improving the efficiency of the agriculture sector as a whole. Further, Technology/Agri-tech/Startup companies were identified and invited to collaborate with the Government of India and develop Proof of Concepts (PoC) based on the federated Farmers' database.

Strengthening National e-Governance Plan in Agriculture (NeGP-A): Under NeGP-A, Funds are released to the State(s)/UT(s) for project involving use of modern technologies, viz. Artificial Intelligence (AI), Machine Learning (ML), Robotics, Drones, Data Analytics, Block Chain etc.

Expanding National Agriculture Market (e-NAM): Government of India has launched e-NAM Scheme with the objective of creating online transparent competitive bidding system to facilitate farmers with remunerative prices for their produce. As on 29 November, 2021, more than 1.72 crore farmers and 2.05 lakh traders have been registered on e-NAM platform. Also, 1000 mandis of 18 States and 3 UTs have been integrated with e-NAM platform as on 29 November 2021. Recently, The Government has approved the integration of 101 APMC mandis (markets or yards) into the electronic platform e-NAM, and thus total number of such mandis is now 1,361.

Integrated Scheme for Agricultural Marketing schemes (AGMARKNET): This is launched to promote creation of agricultural marketing infrastructure by providing backend subsidy support to State, cooperative and private sector investments services are

provided through AGMARKNET portal which is a G2C e-governance portal that caters to the needs of various stakeholders such as farmers, industry, policy makers and academic institutions by providing agricultural marketing related information from a single window. It facilitates web-based information flow, of the daily arrivals and prices of commodities in the agricultural produce markets spread across the country.

Kisan Sarathi: It is an ICT based interface solution with an ultimate goal of creating an intelligent online platform for supporting agriculture at local niche with national perspective. It is intended to provide a seamless, multimedia, multi-ways connectivity to the farmers with the latest agricultural technologies, knowledge base and the pool of large number the subject matter experts. It is a joint initiative of Indian Council of Agricultural Research and Digital India Corporation (DIC), Ministry of Electronics and Information Technology (MeitY), Government of India. Till now, 20,140,96 farmers have been registered in Kisan Sarathi covering 50,124 villages along with 368 KVKs with Interactive Information Dissemination System (IIDS) which has following features:

- Pull and push based advisory system using mobile phones.
- Right information at right time in desired mode and language.
- Customizable and need based information delivery to farmers.
- Know Your Farmers (KYF) facility to subject matter experts.
- Enhances the outreach of national agricultural research, education and extension system.

G20 policy decisions on digitalization in agriculture

G20 Meeting of Agricultural Chief Scientists (MACS) was held in Varanasi (17–19 April 2023). The MACS is the 100th G20 Meeting during India's G20 Presidency. About 80 delegates from G20 Member States; Invited Guest Countries, International Organizations participated in the meeting. Dr. Himanshu Pathak, Secretary (DARE) and Director General (ICAR) chaired the meeting for three days. Subsequently the discussions were held on innovations and technological interventions for agri-food systems transformation, frontiers in science and technology for achieving food security and nutrition, biofortification in food crops for enhancing nutritional value, tropical seaweed farming for nutrition and blue growth, millets and other ancient grains international research initiative (maharishi), one health as an integrated and unifying approach: partnerships and strategies for coordinated action, transboundary pests and diseases: R and D priorities for resilient agri-food systems, climate resilient technologies and innovations for sustainable agri-food systems, nature-positive agriculture: science and innovations for building resilient agri-food system, biological nitrification inhibition (BNI): reducing GHG emissions and increasing crop yields.

Besides these pertinent areas, the delegates

deliberated on digital agriculture and sustainable agriculture value chain, public private partnership in agriculture. India recognizes and appreciated the renewed efforts made by G-20 and other nations/organisations for the digitalisation of agriculture. As the demand for food is set to increase significantly in the decades to come with the rise in population, countries should harness each other's strengths especially opportunities of making agriculture digital. G20 deliberations focused on how India being one of the largest digital connects in the form of over 1.2 billion mobile connections and 1.20 billion plus unique ID-AADHAR holders, can utilize existing digital agricultural platforms. Digital agriculture was seen as one of the important pillar to achieve G20 Presidency theme 'One Earth, One Family, One Future' which signifies collective efforts for achieving SDGs (Sustainable Development Goals).

Centre for Agriculture and Bioscience International (CABI)'s expertise in digital development in bringing science-based agricultural knowledge to millions of smallholder farmers, helping them to increase their yields, was also showcased. 'Digital Agriculture: Digital Farm Advisory- Opportunities and Challenges.' This highlighted the value of public and private-sector extension services and how mobile phone and internet technologies can help give the best advice to farmers—helping them maximise productivity and profits. So far, CABI has identified 830 agricultural digital tools—636 Android apps, 50 Apple apps and 144 websites—all of

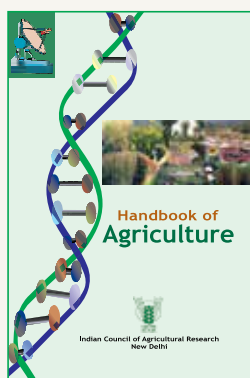
which have been collated within the Crop App Index which was launched in February 2022.

SUMMARY

Agriculture faces several challenges, especially in developing countries due to deficiencies in infrastructure in rural areas. Access, efficiency and affordability of agricultural information continue to be the major impediments for raising agricultural productivity among smallholders in the developing countries. Due to immense population of farmers and different topographies of our country, dissemination of right information in convenient time was the huge obstacle. ICTs can play a very crucial role in digitalization of agriculture and thus by disseminating location specific and timely information to farmers to help them make better and well-informed decisions. Government of India is running many schemes to make agriculture digital, smart and also to increase farmer's income. Special emphasis is being given on electronic and mobile app-based agriculture. Sensors, Internet of Things (IoT), data collection, data analysis tools and IT systems-based agriculture have just started in India. India will have to understand the challenges and possibilities associated with digitalization and smart agriculture and formulate policies to further extend benefits of digitalization to remaining farm families.

*Corresponding author's e-mail: burman_extn@hotmail.com

Handbook of Agriculture



The Handbook of Agriculture is one of the most popular publication of the ICAR with a wider readership. The present edition presents science-led developments in Indian agriculture, the ongoing research efforts at the national level and with some ideas on the shape of future agriculture. While information in some chapters such as Soil and water, Land utilization, field and forage crops has been updated with latest developments, many new topics such as the Environment, agrobiodiversity, Resource conservation technologies, IPM, Pesticides residues, Seed production technologies, Energy in agriculture, informatics, Biotechnology, Intellectual Property Rights, Agricultural marketing and trading and Indigenous Technical Knowledge have been included in the present edition. For those who take intelligent interest in agriculture – and their number is increasing fast – the present edition would serve as a useful book.

TECHNICAL SPECIFICATIONS

Size : Royal Octavo (16 cm x 24 cm) • No. of pages : i-xii + 1618 • Price : Rs 1500 • Postage : Rs 100
ISBN No. : 978-81-7164-096-6

For obtaining copies:

Business Manager

Directorate of Knowledge Management in Agriculture
Indian Council of Agricultural Research
Krishi Anusandhan Bhavan-I,
Pusa, New Delhi 110 012
Tel : 011-25843657, Fax 09-11-25841282;
E-mail : bmicar@icar.org.in