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Precision Agriculture Using Ai-Based Smart Mobile-Apps

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Abstract

With regard to the economy, the farming sector of any country serves as the primary source of livelihood and a crucial backbone that significantly contributes to the global food and feed production. However, traditional and conventional agricultural methods are proving incompetent to suffice the food demands of an exponentially growing population. The major drawbacks of conventional agricultural methods include low yields labor-intensive application of pesticides and fertilizers, delayed detection of pests and diseases, inefficient crop monitoring, which can be overcome by introducing advanced scientific technologies. This transformation has shifted traditional farming towards 'Precision agriculture', which utilizes technologies such as Artificial Intelligence (AI), Machine Learning (ML), the Internet of Things (IoT), and blockchain to provide real-time data to the farmers, thereby boosting crop yields, enhancing the agricultural efficiency, and minimizing the food

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production costs. The use of sensors and other tools in robots, drones and mobile apps, greatly reduces the overuse of water, pesticides, and herbicides, preserves soil fertility, assists in the effective use of manual labour, helps in detection of pests and diseases and finally improves the overall crop yield in both urban and rural areas. Additionally, the modern-age smart farming mobile applications can evidently help the farmers to monitor and manage their farms more effectively by offering real-time updates on weather conditions, soil quality, and crop management. Farmers can use this information, to take knowledge-based decisions about perfect timings to prepare the field, sow seeds, fertilize, monitor and harvest their crops. This review explores how different mobile apps for smart farming contribute to the effectiveness and success of precision agriculture.

Keywords: *Precision agriculture, Artificial Intelligence (AI), crop monitoring, mobile applications, real-time detection, disease detection*

Introduction

Agriculture is one of the world's oldest and most vital professions, playing a crucial role in the global economy. In India, the agricultural sector supports the livelihoods of 58% of the population and contributes to about Rs.1,25,036 crores Gross Value Addition (Deveshwar and Panwar, 2024). It is expected that by the year 2050, the global population might exceed nine billion, necessitating a 70% increase in agricultural production for food security (FAO, 2009). Conventional farming methods tend to be inefficient in

meeting with this ever-increasing food demands, and often leads to heavy economic losses due to several traditional challenges, including reduced soil fertility due to over-fertilization and persistent pesticide use, frequent weather fluctuations, insufficient agricultural data, fluctuating crop prices due to supply and demand, delayed identification of crop issues, process inefficiencies, and irrigation problems. Additionally, rising labor costs, fluctuating crop prices, and increasing cultivation costs also impact farmers negatively. Factors like climate change, population growth, rapid urbanization, security concerns, intense competition for high-quality products, a shortage of skilled labor, and the health risks associated with manual labor are the key reasons why agriculture needs to adopt more advanced and promising techniques.

Precision agriculture, also called as site-specific management, first emerged in the 1980s with the advent of technologies such as GPS (Global Positioning System) for accurate navigation and variable rate input application. Since then, advancements in sensor technology, data analytics, and communication systems have significantly evolved the field. Currently, precision agriculture represents a groundbreaking approach to modern farming. It utilizes advanced technology to optimize crop yields while minimizing resource use and environmental impact. The concept of smart farming is based on the real-time collection, analysis, and application of extensive data, facilitated by the integration of software and mobile applications. Emerging technologies from the Fourth Industrial Revolution viz. Artificial Intelligence (AI), Machine Learning (ML), big data, drones, and the Internet of

Things (IoT) are successfully introducing rapid and extensive transformations in the field of agriculture (Jha et al., 2019; Bannerjee et al., 2018; Smith, 2018). Precision agriculture depends on specialized softwares, equipments, and information technology services that continuously gather data regarding crops, soil, climatic conditions, and other critical factors such as labor costs, etc. (Raj et al., 2021). The use of IoT and Artificial Intelligence (AI) support the remote sensing of the fields to monitor and collect crop-related information like weather details, soil nutrients, and the presence of pests and weeds to the farmers, which is further analyzed to provide actionable recommendations on crop rotation, soil management, harvesting schedules, and optimal planting times. Alongside the sensors, satellites and drones provide real-time plant images to the farmers that helps them to take immediate decisions on crop cultivation and field irrigation (Abbasi et al., 2014). Meanwhile, agricultural control centers assist in integrating the imaging and sensor data with other real-time information for field mapping and identification of necessary hotspots. This approach greatly reduces runoff and water wastage, lowers costs, and reduces the farm's environmental impact. These cost-effective and eco-friendly smart farming practices involve the advanced capabilities of intelligent farm machinery and improve the overall farm management performance. Earlier, precision agriculture was restricted to larger operations with the financial resources to invest in IT infrastructure and technical tools. However, advancements in cloud computing, drones, smart sensors, and mobile apps have now made precision agriculture accessible to small family farms and farming cooperatives (Shibusawa, 2002).

1. Artificial Intelligence in Smart Farming

Artificial Intelligence (AI), a term introduced at the Dartmouth Conference (McCarthy, 1955), is an interesting branch of computer science that involves smart machines and simulates human behavior to choose the best possible ways to reach specific goals. Evolution of AI has not only impacted IT and allied sciences, but also offers numerous benefits to agriculture. In the year 1985, AI technology was first applied to agriculture when GOSSYM, a cotton crop simulation model was developed by McKinnon and Lemmon to optimize cotton yields by monitoring irrigation, fertilization, and weed control (Gertsis et al., 1998). With the advancements of AI over the years, significant improvements have been introduced in the farming sector to reduce the excessive use of water, herbicides, and pesticides, and also assess soil pH, fertility, and crop adaptability to specific geographical regions. Vast amounts of field data are collected using Internet of Things (IoT) (a system where devices can communicate with one another over a network without needing human intervention or interaction), which is then processed and analyzed to address crop-related issues and make decisions to achieve optimal outcomes. IoT is used in farming for tasks such as irrigation, soil moisture measurement, and soil temperature monitoring (Shekhar et al., 2017). Smart irrigation systems employ sensors to measure soil moisture, while temperature sensors track changes in humidity and temperature. The advancement of efficient IoT based smart irrigation systems undeniably present a valuable solution for farmers, empowering them to remotely monitor

their crops and control field parameters (Obaideen et al., 2022).

Safeguarding crops from environmental changes, labor issues, food demands, and population growth poses potential challenges to agriculture, which are now being resolved by AI using robots, drones, and mobile apps for pesticide spraying, irrigation, planting, predictive analytics, weeding and harvesting (Eli-Chukwu, 2019; Waleed et al., 2020). Drones or the unmanned aerial vehicles (UAV) are being employed in the farming sector to assess the soil fertility, map the fields, sow seeds, recognize weeds, spray insecticides and fertilizers, and forecast and monitor the crops effectively (Dutta and Goswami, 2020). This approach significantly reduces the excess use of water, herbicides, and pesticides and also aids to assess the soil pH and fertility to choose the best crops for specific geographical terrains. Machines utilizing AI and ML models can further analyze the data to identify and reveal new traits in plants that greatly improve crop quality as well as productivity (Talaviya et al., 2020).

Variable-specific sensors and remote-controlled robots are being widely engaged to manage and monitor crops, especially in huge farms which are difficult to surveil manually (Zha, 2020). The advent of intelligence-based computerized robots known as ‘Agri-bots’ lucratively assist the farmers effectively to protect their crops from pests and weeds. AI-powered robots can harvest crops more efficiently in much less time compared to human workers, thereby addressing the labor challenges as well (DeBoer et al., 2019). Specially customized mechatronic robots that are operated

from remote locations have been expediently designed to perform agricultural operations without any human involvement like land preparation, sowing, transplanting, weeding, crop scouting, pest control and harvesting. The development and widespread use of agri-bots in both urban and rural areas have raised the bar of smart agricultural practices on a global scale (Valle and Kienzle, 2020; Liveira et al., 2021).

Apart from the efficient use of modern agricultural practices, it is equally important to use the gathered data and store it effectively. Collection, analysis and storage of agri-based datasets is successfully brought about by the ICT (Information and Communication Technology) tools like blockchain technology (Walter et al., 2017). Blockchain is being widely applied for managing the agricultural data securely, recording crucial information from the farms, and enabling peer-to-peer transactions with complete transparency without involving banks or other intermediaries (Haveson et al., 2017). Other applications of blockchain in agriculture includes registration of farmland, supply chains for food and crops, transport and transaction of products, real-time payments, safety and traceability of food products, packaging and agricultural insurance. This greatly improves the reliability and sustainability of agricultural practices (Hang et al., 2020).

2. Smart mobile Apps Used in Precision Agriculture

Ever since, ICT tools have shown their impact on smart farming, tools like mobile apps that function as intelligent Decision Support Tools (DST), are being utilized for

increasing the sustainability in agricultural and rural development in India. Our country has been positioned as one of the leading users of internet and mobile phones worldwide (IAMAI, 2019). Owing to their low costs, consistent integration with various cellular networks, advancements in smartphones and app developers, mobile applications are now replacing many of the computer-based services. Latest smartphones equipped with touch screens, bright displays, high-resolution cameras, sufficient memory, and 3G or 4G internet, have captured the attention of users. Adoption of more affordable mobile handsets, the expansion of wireless data networks, and changing consumer preferences are driving increased internet use in agriculture and related fields in both urban and rural areas. This necessitates the availability of e-mobility and a continuous connectivity of internet, using which farmers can gain easy access to information such as best agricultural practices to be used, current market prices and demand of commodities, policies and agri-programs available for them to maximize their profits. For this purpose, mobile or smartphone applications, commonly known as ‘apps’ are being developed to offer a convenient platform for the farmers, where they can reach out to farm-related data and solutions in just a single touch or query.

The inception of mobile apps has greatly influenced the transmission of valuable agronomic information to the farmers and also aided in improving their connectivity to the digital resources for providing timely and relevant solutions to all farm-related issues (Mandi and Mandal, 2020). A wide range of smartphone apps are now available to offer latest information regarding agricultural trends, equipment,

technology and allied sectors. These apps provide real-time climatic status, warnings about bad weather, timely management of pests and diseases, feature best price offers in the local markets and enable the farmers to connect with agricultural experts worldwide for gaining advice and support in their local language. Based on the information, content and applications, numerous apps have been developed for agricultural purposes, each app varying in specific functionality and features. The agriculture-based mobile applications are usually categorized into Agri-crop mobile applications, Multi-informative mobile applications, Calculative mobile applications, Diagnostic mobile applications, Agri-academic mobile applications, and Agri-professional mobile applications (Barh and Balakrishnan, 2018).

3.1 Agri-crop Mobile Applications

Agri-crop mobile applications mainly focus on giving information about efficient farming practices, market reviews and weather predictions in multiple regional languages offering a better understanding of crop cultivation and production to the farmers. For example, the **Agri-app** furnishes a detailed guidance on easy farm practices for field crops like rice, maize, cotton, sugarcane etc. It gives information, relevant news and instructional videos in three different languages that can be accessed by simple registering into the app to receive expert advice via chat or voice calls (Criyagen, 2016). The **KisanYojana app**, launched by Agriculture News Network (ANN), displays information regarding various government schemes and benefits for rural

farming communities across eight major Indian states (ANN, 2016). Several **Weather apps** like the Skymet weather app, India Satellite Weather, Weather Pro, and Weather Timeline app, allows prediction of climatic conditions and temperature fluctuations in different local languages which helps in planning the farm operations (Weather Skymet, 2016). **Soil Web app** uses GPS to provide real-time access to USDA-NRCS soil survey data, including soil types and detailed soil analysis based on the user's location (DAVIS UC, 2016).

3.2 Multi Informative Mobile Apps

Apps have been developed for extending a varied range of multidisciplinary farming approaches from land preparation and sowing the seeds to marketing the products successfully, all-inclusive under one platform. For instance, the **IFFCO App** supplies climatic updates from Indian Meteorological Department (IMD) and current market price of crops from Agmarket and National Commodity and Derivatives Exchange Limited (NCDEX). It also broadcasts news on available government schemes and initiatives and renders agri-advice in ten different Indian languages (IFFCO, 2016). Similarly, the **myRML app**, developed by Reuters Market Light (RML), is equipped with advanced agricultural information for majority of the cultivated crops and caters to all agricultural resources in the form of quizzes, success stories, government schemes, mechanization and sustainability (RML, 2016).

3.3 Calculative Mobile Apps

There are many apps available for academic purposes that abet in calculating the agricultural input and output data like seed inventory, spacing of crops in the field and amount of fertilizer to be applied. **AgPhD Harvest Loss** estimates yield losses per acre for crops like wheat, barley, oats, soybean, and maize, and calculates financial losses based on current market prices (AgPhD, 2016d). **AgPhD Planting Population** determines optimal spacing for planting populations per acre and aids in maintaining plant stands and thinning operations (AgPhD, 2016a). **Fertilizer Calculator** converts nutrient content of fertilizers (nitrogen, phosphorus, potassium) into various combinations, such as Urea-Single Super Phosphate-Muriate of Potash, and provides eleven different fertilizer mix options (Koti, 2016).

3.4 Diagnostic Mobile Applications

Various **Disease management apps** play a pivotal role in sustainable agriculture by recognizing plant pathogens, pests and diseases and suggesting the preventive measures and treatment, thereby reducing the damage to crops. Diagnostic apps to identify deficiencies and symptoms include **AgPhD Deficiencies** imparts knowledge and clear photographs of deficiency symptoms for 36 crops and 14 key nutrients, including common issues like zinc deficiency in rice (AgPhD, 2016b). **AgPhD Field Pest Identification and Control** offers basic pest identification and control information with photographs for insects and weeds. Useful for both farmers and extension workers, it includes features for saving field

pest information and submitting reports (AgPhD, 2016c). Most of the disease management apps also allow severity assessment of diseases and generate solutions based on market features to reduce economic losses (Bedi, 2021). Some of these apps have been listed in Table 1.

Table 1: List of some mobile apps used for disease detection (Siddiqua et al., 2022)

Name of the App	Country of Origin	Platform	Downloads	Free/Paid
Agrio	United States	Android and iOS	100K+	Free
AgroAI—Plant Diseases Diagnosis (Early Access)	Africa	Android	10+	Free
Cassava Plant Disease Identify	Unknown	iOS	—	Paid
Cropalyser	Netherlands	Android	10K+	Free
Garden Plants Diseases Detector	Unknown	iOS	—	Paid
Leaf Doctor	United States	Android and iOS	10K+	Free
Leafy	India	Android	100+	Free
PDDApp: Plant Disease Detection	Russia	Android	1K+	Free
PestozIdentify Plant Diseases	India	Android	10K+	Free
Plant Disease Detector	Unknown	Android	10+	Free
Plant Disease Identifier	Unknown	iOS	—	Paid
Plant Diseases and Pests	Unknown	iOS	—	Paid
PlantDoctor	India	Android	1K+	Free
PlantifyDr	United States	Android and iOS	10+	Free
Plantix—your crop doctor	Germany	Android	100K+	Free
Plants Disease Identification	Unknown	iOS	—	Paid
Riceye	Unknown	Android	5+	Free

Plantix is one of the most widely used mobile apps for disease detection and to monitor climate changes, irrigation, soil issues and supply chain gaps in crop plants (Figure 1). This app accurately predicts weather patterns, reduces wastage of resources and helps to adopt better sustainable irrigation practices for better yields and income. The **PlantifyDr** app uses ML algorithms to identify a plant and detect diseases based on the morphological symptoms. Figure 2 depicts the use of **PlantifyDr** app for plant identification. For the identification of infected parts, comparison of damaged and healthy leaf tissues and calculation of disease severity percentage, apps like **AgroAI–Plant Diseases Diagnosis (Early Access)**, **Leaf Doctor**, **Riceye** etc. are used. The screenshots of disease detection using Plantix and AgroAI apps is shown in Figure 3. Almost all plant disease detection apps include log-in or sign-up information, data export option, real-time notifications, multi-language support, and an onboard tutorial for a smooth user experience.

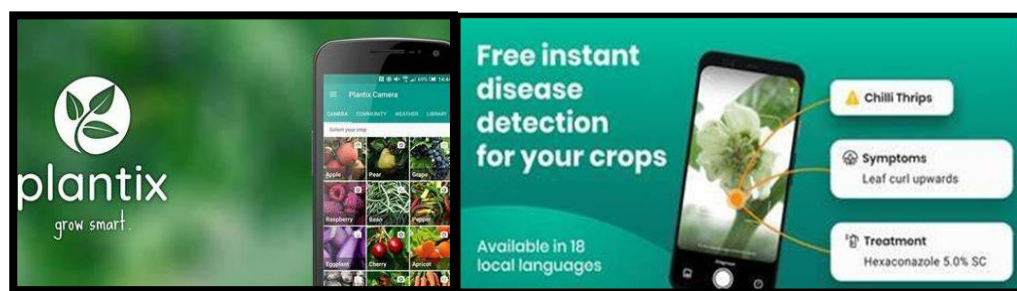


Figure 1: Disease detection app Plantix- your crop doctor.

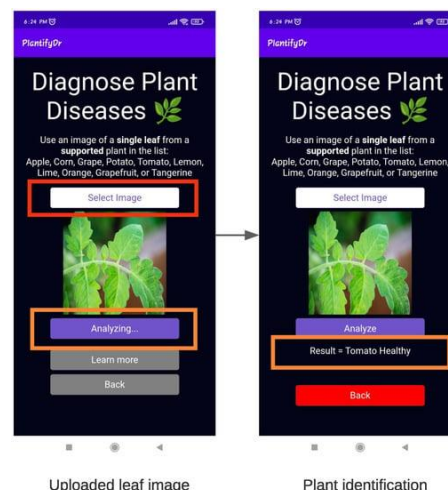


Figure 2: Use of PlantifyDr app for plant identification (Siddiqua et al., 2022)

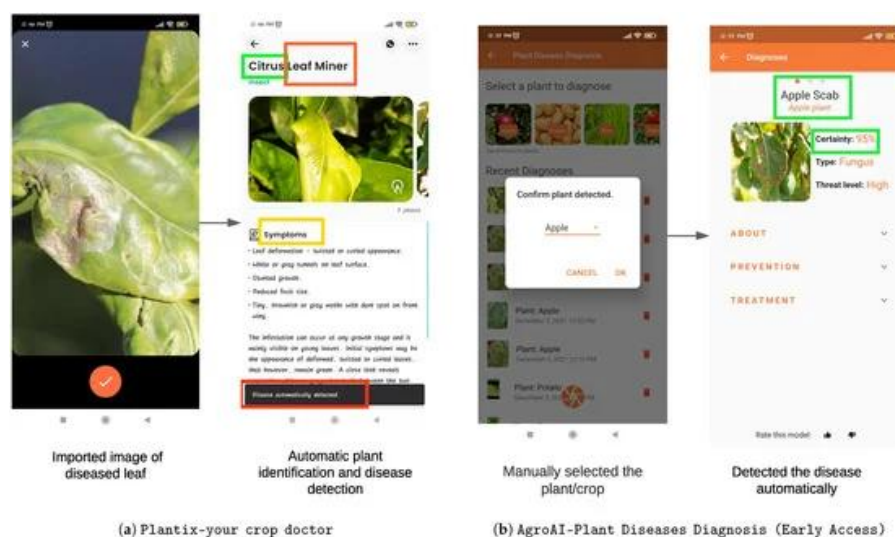


Figure 4: Disease detection by the apps (a) Plantix and (b) AgroAI (Siddiqua et al., 2022)

3.5 Agri-Academic Mobile Apps

Multiple educational tools have been designed to help students, researchers, agricultural professionals, and farmers understand agriculture-related terms and concepts. These apps are widely used in academia and include dictionaries and

learning modules. Examples include **agriculture dictionaries** with over 6,500 terms and abbreviations related to topics such as livestock, horticulture, plant breeding, economics, communication technologies, weather, agricultural policies, and the environment. This particular dictionary was compiled by European Union Agricultural Statistics experts (Ermilogic, 2016).

3.6 Agri-Professional Mobile Apps

Such apps cater to scientists, agri-professionals, and policy makers, offering a range of functionalities, from research highlights to laboratory tools for soil analysis and PCR techniques. **Laboratory Apps** aid in specialized techniques like PCR and soil testing, focusing on standardization and protocol calculations. They require technical skills in specific areas. **Research Highlight App** developed by Elsevier, helps scientists and researchers access over 20,000 journals and stay updated on emerging research (Elsevier, 2016). **Agriculture Policy Research App** provides updates on agricultural policies, offering valuable information for new researchers and supporting national development (Agricultural Policy Research, 2016).

Recently, the Government of India has also taken initiatives and launched knowledge sharing and support platforms like the **M-Kisan portal** connecting agronomy specialists with rural farmers through mobile phones, broadcasting significant information via SMS to approximately 146 million farmers across the country (mKisan, 2016; GOI, 2016). The **Shetkari Masik Android App** provides access via mobile, internet, or

Wi-Fi to the Shetkari Masik agricultural magazine, published since 1965 by the Department of Agriculture, Maharashtra. Other such apps include the **Farm-o-pedia**, primarily targeting farmers of Gujarat regarding crop-specific information; the **Bhuvan Hailstorm App** to estimate crop losses from hailstorms; the **Crop Insurance Mobile App** that calculates insurance premiums for crops based on area, coverage amount, and loan details for loanee farmers; the **AgriMarket app** giving updates on daily market rates for various agricultural commodities, helping farmers sell their produce at reasonable prices. Some more important Indian apps with their applications are listed in table 2.

Table 2: Some modern Indian agricultural apps and their applications (Raman et al., 2021; Sarkar et al., 2021).

Name of the App	Applications
KisanSuvidha	It provides information on current climate conditions and a 5-day weather forecast, market prices for commodities and produce in the nearest town, as well as details on fertilizers, seeds, machinery, and more.
IFFCO Kisan Agriculture	The user can access various informative modules, including market prices, weather updates, agricultural information, and a data library in text, audio, images, and videos in the selected language. The app also provides helpline numbers for contacting Kisan Call Centre services.

PusaKrishi	This app is designed to assist farmers by providing information on technologies developed by the Indian Agricultural Research Institute (IARI) that can boost their returns. It also offers data on new crops developed by ICAR, aiming to enhance farmers' profitability.
Meghdoot	It offers weather forecasts for temperature, rainfall, humidity, wind speed, and direction, crucial for agricultural operations. It provides crop and livestock care advisories and updates information twice a week, on Tuesdays and Fridays.
Kheti-Badi	This social initiative app promotes and supports organic farming by providing essential information and addressing issues to help farmers transition from chemical to organic practices.
Krishi Video Advice mobile app	It aims to bridge the information gap between farmers and experts. Compatible with all Android smartphones and tablets, it allows farmers or extension officers to capture and upload three live images of a crop from the field. Kisan Call Center (KCC) experts then provide advice based on these images.
Soil Health Card (SHC) Mobile App	This app provides farmers with soil nutrient status and fertilizer dosage recommendations to maintain long-term soil health. It also identifies nutrient

	deficiencies and suggests corrective measures, while automatically capturing latitude and longitude when "Location" is enabled.
APEDA Farmer Connect	This mobile app allows farmers to apply online for farm registration and lab sampling approval. Authorized State Government Officers, farmers, or registered laboratories can log in to access information. It also features GPS capabilities to identify the farm location.
Kultivate	Kultivate is a mobile app designed to bridge gaps in traditional agricultural extension, making "Smart Agriculture Extension" accessible and easy for everyone.
e-NAM Mobile App	The National Agriculture Market (NAM) is a government-promoted electronic trading portal that connects existing mandis to create a unified national market for agricultural commodities. The mobile app enables remote bidding for traders and provides farmers and stakeholders with arrival and price information on their smartphones.
Digital Mandi India	This app provides the latest Mandi prices for agricultural commodities from various states and districts across India.
My Agri Guru	MyAgriGuru connects farmers with agri-experts nationwide, covering interactions

	on over 90 crops, including Cotton, Wheat, Tomato, as well as non-traditional crops like Tulsi, Aloe Vera, and Flowers.
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Many more recent AI-based apps have enhanced smart agriculture by offering valuable tools and insights like the **yieldsApp**, which utilizes AI to provide field-specific recommendations for managing pests, diseases, and nutrients; **AkerScout** to monitor crop conditions and highlights areas requiring immediate attention; **Farmobile** which notes and collects data from equipment equipped with Electronic Field Records (EFR). The **OneSoil app** assists users in identifying problem areas in their fields by creating notes, taking photos, sorting fields, and checking weather forecasts. **Auravant** employs algorithms to help users make decisions that boost field productivity. The **Slakes app** from Soil Health Institute gives an indication of wet aggregate stability by photographing the soil-aggregates before and after watering. Notable apps such as **Cropin Grow (SmartFarm)**, which offers farm digitization and business intelligence solutions; **Smartware**, a pack-house solution for inventory management and food traceability; **FarmCommand**, a farm-data management app for field-centric forecasts and **Smartrisk**, an agri-business intelligence tool that provides insights into production risks and forecasts, are being widely used (Hopkins, 2024).

Another interesting sowing app was developed by Microsoft India and the International Crops Research Institute for Semi-Arid Tropics (ICRISAT) with a customized village advisory dashboard for Andhra Pradesh. This **RythuKosam app**,

manually collected data from farms across 13 districts in the state and uploaded it to Microsoft's Azure Cloud. The dashboard provides essential insights on soil health, fertilizer recommendations, and a seven-day weather forecast, utilizing advanced Business Intelligence (BI) techniques. This eventually helped to minimize crop failures, boost yields, reduce stress, improve income and has brought about a profound transformation in the agricultural landscape fostering informed and efficient farming practices.

4. Advantages and Disadvantages of Using Mobile Apps in Agriculture.

Modern day smartphone applications serve beneficial to agriculturists by administering comprehensive and readily accessible information on climate, soil, field-grown crops and farm-machinery apart from presenting facts and figures on policies and economics. They support improved market connectivity and allows the farmers to engage directly with buyers and sellers, receive real-time commodity prices, track investments and stay aware of the insurances and bank statements pertaining to an organized production process (Sarkar et al., 2021). Mobile phones also help in taking stock updates, tracking the consignments and ensuring timely deliveries of the products. The applications of mobile apps in agriculture sector are vast as they provide knowledge-based advisories via text and video messaging; offer real-time weather data (temperature, rainfall, sunshine) affecting decision-making; supply market intelligence on prices, quality and quantity; enable online monitoring and management of crops, livestock, poultry, and fisheries; facilitate feedback and

queries from farmers and stakeholders; deliver government services, including inputs and subsidies, to farmers; assist in irrigation management, sensor-based farming, and soil type identification; support effective farm management through data recording, analysis, and recommendations; allow quick retrieval and reference of vast information; and enhance marketing and storage of agricultural produce.

Despite so many advantages, the mobile apps have some drawbacks. The huge language diversity nationwide can hinder the usability if apps do not support regional languages and proper translations. Network issues, slow data delivery, and legal restrictions can also prevent farmers in villages from accessing up-to-date information. Additionally, understanding and translating complex functions or ambiguous content may require skilled personnel. Hence, digital literacy is mandatory. In developing nations, farmers may struggle with the cost and data demands of these apps (Raman et al., 2021; Sarkar et al., 2021).

Conclusion

In a country as highly populated as India, dissipating important information and reaching out to farmers in every region, poses a big challenge to the agricultural system, which is addressed by the use of modern digital tools. Supported by ICT and IoT, these tools efficiently provide the real-time information about variable factors like climatic conditions, water status, seed, soil quality, fertilizers, pest management and market prices to maximize profits and minimize crop losses. The integration of data-driven decision-making AI-

based technologies and mobile apps have particularly proven beneficial to small and marginal farmers and has brought about a big shift from conventional farming methods to smart precision agriculture. The AI-based apps are utilizing data generated from sensors and satellite images to offer timely alerts and recommendations for accurate location-specific weather forecast, crop monitoring, early identification of diseases and pests, timely fertilizer and pesticide application and other important farming decisions. A comprehensive view of farm operations along with well-defined market insights and online marketing platforms helps to decide the optimal prices, access markets directly without intermediaries and choose perfect place and timing to sell the products. Advanced apps further promote intelligent connections between farmers and government policy support. Smartphone with simple applications facilitates farmers to receive agricultural advice via text and voice messages even in remote rural areas, which helps them to improvise the farming practices and increase crop productivity. Digital tools like the E-wallet not only enhance the affordability of agricultural inputs, but also benefit the government and private sector for creating awareness about the subsidies and for managing input stocks during emergency situations. At times, challenges such as unaffordable handsets, incompatible software, low speed of internet in rural areas, inadequate digital literacy, and poor availability of local language platforms can slow down the progress. Hence, future app developers require to address these issues and ensure incorporation of new functionalities to augment the app performance even in unfavourable situations. It is also necessary to expand the use of app-based information by creating awareness and training the farmers to

explore new apps and available resources maximally for their benefits. Nevertheless, digital revolution with better access to internet and wise choice of apps offer reliable and up-to-date information, which helps the farming sector to resolve numerous challenges and requisites of modern agriculture. Thus, smart farming is the future of agriculture.

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