PRECISION CROFTING IN INDIA: INNOVATIONS AND CHALLENGES

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Abstract-**The use of Artificial Intelligence (AI) in agriculture has been gaining popularity in recent years. In India, the Budget 2023 has recognized the importance of AI in agriculture and has allocated funds towards the development of AI-based solutions for soil and crop management. Start-ups in this field are also receiving support from the government. The main concept of AI in agriculture is its flexibility, high performance, accuracy, and cost-effectiveness. This paper presents applications of AI in soil management and crop management. A special focus is laid on the start-ups, trends and limitations of the artificial intelligence in agriculture and the way in utilizing expert systems for higher productivity.**

Keywords- ***Artificial Intelligence, Agriculture, Soil Management, Crop Management and Budget 2023 JEL Code: O31, Q22, Q24 and H61***

I. INTRODUCTION

The agriculture sector in India is vital to the economy, providing livelihoods to millions of people and contributing significantly to the country's Gross Domestic Product (GDP) (Mishra & Roshan, 2020). However, this sector faces numerous challenges, including climate change, water scarcity, and market volatility, which can negatively impact crop yields and farm incomes (Vivek et al., 2021). To tackle these challenges, the use of artificial intelligence (AI) in agriculture has emerged as a promising solution in recent years (Huang et al., 2020).

AI-based tools and technologies can provide farmers with data-driven decision-making capabilities by offering real-time information on weather, soil moisture, crop health, and market prices (Mishra &Roshan, 2020). This can help optimize the use of resources, reduce waste, and increase crop yields and farm incomes (Vivek et al., 2021). Therefore, the use of AI in agriculture can potentially contribute to achieving sustainable agricultural growth, which is essential for India's economic development and food security (Huang et al., 2020). India's agriculture sector is a significant contributor to the country's economy, employing over 50% of the workforce and contributing 17-18% of the GDP (Economic Survey, 2020-21).However, the sector faces various challenges such as water scarcity, climate change, and low productivity, which require innovative solutions to overcome.The Indian government has recognized the potential of AI-based solutions for agriculture and has been investing in them to address the sector's challenges. In the recent Budget 2023, INR 2,000 crores ($270 million) has been allocated for the National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS), which includes AI- based solutions for agriculture (The Economic Times, 2022). This allocation is expected to encourage the development and adoption of AI- based solutions in the sector, which can help farmers make informed decisions and improve crop yields and farm incomes.

The upcoming Union Budget 2023 will be a crucial event to watch, as it can potentially impact the application of AI in agriculture in India. A budget allocation that prioritizes the development and adoption of AI-based solutions can create an enabling environment for the growth of the sector, which is essential for India's economic development and food security.

II. REVIEW OF LITERATURE

Kaur.P & Singh.K (2020) In this article, the authors discuss how AI can be utilized in various stages of precision farming, including data monitoring and analysis, decision-making, and automation of farming tasks. They highlight the benefits of using AI in each stage, including increased efficiency and accuracy in crop management, improved resource utilization, and increased crop yields and provides an extensive overview of the potential applications of AI in agriculture in India, including precision farming, crop yield prediction, pest detection and soil nutrient management.

Singh.D.K. Kumar.R & Kumar.V (2021) This article provides an in-depth analysis of the potential benefits of AI in agriculture in India, such as increased productivity, improved efficiency, and better decision-making capabilities for farmers. It also discusses the challenges and limitations of implementing AI in agriculture in India.

Nair.S, Madan.M, Kumar.A & Bhatia.R. (2020) This article reviews the current state of AI adoption in Indian agriculture and discusses the potential benefits of using AI in various farming practices, such as precision farming, livestock management, and supply chain management. The authors also highlightthe challenges and opportunities ofimplementing AI in agriculture in India.

Babu.A.M, Chauhan.A & Kumar.V (2021)This article focuses on the use of AI and machine learning for crop disease detection in Indian agriculture. The authors review various machine learning techniques and their applications for crop disease detection, including image processing, pattern recognition, and data analytics.

suchandra Dutta, Shantanu Rakshit and Devayan Chatterjee (2020) This article gives a quick summary of emerging artificial intelligence-based technologies and how research scientists and extension specialists are now using them to address issues with agricultural production and management in India. The development of artificial intelligence (AI) technology has allowed farmers to keep an eye on the health of their crops or the transfer of their animals away from their farm, which makes farming more productive and labour-intensive. This article cites some AI-based agricultural interventions in India and emphasises the importance of agricultural extension in evaluating the technology.

III. USE of IFARMING

In the monitoring stage, AI can analyse data from various sources such as satellite images, weather data and soil sensors to provide insights on crop growth, pest infestations and other factors affecting crop health. In the decision-making stage, AI can help farmers make informed decisions on crop management, such as when to irrigate, fertilize and harvest. In the action stage, AI can automate various farming tasks such as planting, weeding and spraying. (Kaur, P., & Singh, K. (2020)).

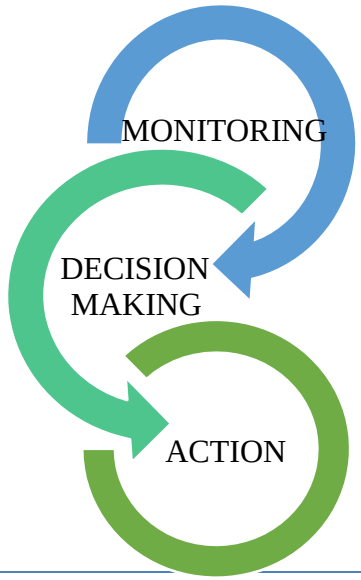

Fig 1: The use of AI in agriculture classified into three categories

AI- Agri in India use of drones for crop monitoring. Drones equipped with cameras and sensors can capture high- resolution images of crops, which can be analysed using AI algorithms to provide insights on crop health and growth. This technology has been successfully deployed in states such as Punjab and Haryana, where farmers have reported increased crop yields and reduced input costs.

The use of AI-based chatbots for providing agricultural advice to farmers. In 2019, the Indian government launched a chatbot called Kisan Mitra to provide farmers with real-time advice on crop management, pest control and weather forecasting. The Chabot uses natural language processing (NPL) to understand and respond to farmers queries in regional languages.

IV. COGITATION OVERVIEW

The application of artificial intelligence (AI) in agriculture in India has the potential to transform the sector by improving crop yields, reducing crop damage, and enhancing farm income. AI-based tools and technologies have the potential to revolutionize the agriculture sector by providing farmers with real-time dataon weather, soil health and crop yields.

The challenges: While the potential benefits of AI in agriculture are significant, there are also challenges that need to be addressed. For example, thehigh cost of AI technology and the lack of infrastructure and connectivity in some parts of rural India can limit the adoption of AI-based solutions. There is also a needfor capacity-building programs to help farmers and other stakeholders understand and use AI tools effectively.

The regulatory environment: The use of AI in agriculture in India is still in its earlystages, and there is a need for a regulatory framework to govern its use. This framework should address issues such as data privacy, ownership, and intellectual property rights, as well as the ethical implications of using AI in agriculture.

The role of public-private partnerships: Collaboration between the government, private sector, and research institutions can help drive the adoption of AI in agriculture in India. Public-private partnerships can help address the challenges associated with AI adoption by providing funding, expertise, and technical support to farmers and other stakeholders.

The need for context-specific solutions: Agriculture in India is diverse and complex, with different crops, weather patterns, and farming practices across different regions. Therefore, the use of AI in agriculture should be context-specific, with solutions tailored to the specific needs and challenges of different regionsand crops.

V. RECENT TRENDS INFORMATIONon AI-AGRI in INDIA

According to report by Research and Markets, the Indian precisionagriculture market is expected to grow at a CAGR of 12.2% from 2021 to 2026. The Indian government's flagship crop insurance scheme, Pradhan Mantri Fasai Bima Yojana (PMFBY), is set to use AI and machine learning technologies to improve crop yield estimation and damage assessment. In 2021, Indian startup Crofarm raised $5 million in funding to develop its AI-powered platform for predicting crop yield and disease outbreaks.

According to a report by AgFunder, Indian agritech startups raised $438 million in funding in 2020, with precision agriculture being one of the top areas of investment. The Indian Council of Agricultural Research (ICAR) has launched a project to develop an AI-based mobile app for crop management and advisory services. The app will provide real-time advice to farmers on crop health, pest and disease management and weather forecasting.

VI. STARTUPS of AI TECHNOLOGY

AI technology has been gaining momentum in the Indian agriculturesector in recent years, with several start-ups' and companies focusing on using AI to improve crop yield, reducewastage and increase profitability for farmers.

Fig 2: AI Technology Startups in India

CropIn Technology: This Bengaluru based startup provides AI-powered software solutions that help farmers and agribusinesses to manage their crops efficiently. Its platform provides data-driven insights to help farmers make informed about decisions to improve their crop yields, optimize resource usage and reduce risks. The company's platform provides real time insights into crop health, weather patterns, soil conditions and other factors that affect crop growth and quality.

AgNext: AgNext provides an AI- based quality testing platform for agricultural produce. The platform uses spectroscopy and other technologies to provide real-time analysis of crop quality and nutrition, helping farmers and other stakeholders make informed decisions.

SatSure: SatSure is an AI-driven platform that uses satellite imagery, weather data and other information to provide insights into crop health and soil moisture levels. The platform helps farmers optimize their resource usage and improve their crop yields.

VII. SOIL MANAGEMNET- AI

Soil management AI refers to the use of artificial intelligence (AI) technology to improve soil management practices. This can include a range of applications, such as precision agriculture, soil analysis and nutrient management. When it comes to implementing soil management AI, the budget can be a significant factor. However, there are several options available that can fit within different budget ranges.

Low Budget:

Soil Sensors: Soil sensors are acost-effective way to collect data on soil moisture, temperature and other important variables. These sensors can be used to optimize irrigations and nutrient management practices, which can lead to improved yields and lower input use.

Basic Decision Support Systems: there are several free or low-cost decision support system are AI- powered tools are available that can help farmers make informed decisions about crop management. These systems use data from sensors and other sources to provide recommendations on planting, irrigation and nutrient management based on data inputs.

Mid-range Budget:

Remote Sensing: Remote sensingtechnologies, such as satellite imagery and aerial drones, can be used to monitor soil

health and crop growth. These tools can help to identify areas of the field that require more attention and can help optimize input use. The cost of remote sensing an vary depending on the type of technology used, but prices can start at around $1,00.

Precision Agriculture Tools: Precisions agriculture tools, such as variable rate technology (VRT) and autosteer, can help farmers optimize input use by applying fertilizers and pesticides only where they are needed. These tools can improve efficiency and reduce costs over time. The cost of VRT systems can range from a few thousands to tens of thousands of dollars, depending on the complexity of the system.

High Budget:

Advanced Decision Support Systems: Advanced decision support systems can provide more detailed recommendations for crop management based on data inputs. These systems may include machine learning algorithms can be used to analyze soil and weather data to provide more accurate predictions about crop growth and yield.This is customized for specific crops and growing conditions. The cost of advanced decision support systems can range from tens of thousands to hundreds of thousands of dollars. This can help farmers make more informed decisions about planting and harvesting.

Advanced Remote Sensing: Advanced remote sensing technologies, such as hyperspectral imaging, can provide even more detailed information on soil health and crop growth. These tools can help identify nutrients deficiencies and other issues that may not be visible to the naked eye. The cost of advanced remote sensing technologies can be inthe hundreds of thousands of dollars.

VIII. CROP MANAGEMENT-AI

AI-based crop management has emergedas an important tool for farmers in India to improve crop yield, reduce wastage and optimize resource utilization. The new budget 2023 in India is expected to continue the focus on agriculture growth and sustainability, with a special emphasis on promoting the use of AI-based technologies in crop management. The government may allocate funds to support research and development in the field of AI-based crop management, as well as provide financial support to farmers who adopt these technologies.

Some of the key reforms that may be introduced in the new budget for crop management in India include:

Investment in Infrastructure and Logistics: the government may invest in improving the infrastructure and logistics for the distribution of agriculture products. This can help reduce wastage and increase profits for farmers.

Support for organic farming: The government may provide financial support to farmers who adopt organic farming practices. This can help to promote sustainable farming practices and reduce the use of harmful chemicals.

Promotion of smart farming practices: the government may promote the use of smart farming practices such as precision agriculture, which uses AI-based techniques to optimize crop management practices such as irrigation, fertilization and pest control.

Support for research and development: thegovernment may allocate funds for research and development in the field of AI-based crop management. This can help farmers adopt new technologies and improve their crop yield and profitability.

Crop insurance schemes: The government may continue to support crop insurance schemes such as Pradhan Mantri Fasal Bima Yojana, which provides insurancecoverages and financial support to farmersin case of crop failure or damage.

There are many AI tools available for crop management, some of which are:

CropX- CropX is an AI based platform that uses sensors and algorithms to help farmers optimize the irrigation and fertilization practices. It helps farmers to monitor soil moisture levels, track weather patterns and make informed decisions about when to irrigate their crops.

AgroScout- AgroScout is an AI based platform that helps

farmers to identifyand diagnose crop diseases in real- time. It uses computer vision and machine learning algorithms to detect symptoms of diseases in crop and provides recommendations fortreatment.

Prospera- Prospera is an AI-based platform that helps farmers to monitor their crops using drones and sensors. It uses computer vision and machine learning algorithms to analyze images of crops and identify areas that need attention, such as irrigation or fertilization.

FarmBeats- FarmBeats is an AI based platform developed by Microsoft that help farmers to make data-driven decisions about their crops.it uses sensors, drones and machine learning algorithms to collectand analyze data on soil moisture, temperature and other factors that affect crop growth.

Taranis- Taranis is an AI based platform that uses drones and sensors to monitor crops and detect potential problems. It uses computer vision and machine learning algorithms to analyze images of crops and identify issues such as pests, disease or nutrient deficiencies.

IX. LIMITATIONS on AI-AGRICULTURE in INDIA

While there are numerous benefits to AI agriculture in India, there are also some limitations and challenges that need to be addressed. Here are a few:

Limited internet connectivity: A significant proportion of farmers in India lack access to high-speed internet, which can make it difficult to use AI-powered tools and technologies that rely on real-time data.

Limited availability of data: AI algorithms require large amounts of data to train and improve, but in India, there is a lack of quality data on soil types, weather patterns and other factors that affect agriculture production. This can make it difficult to develop effective AI-based solutions.

High cost of implementations: The cost of implementing AI agriculture technologies, such as sensors and drones, can be high which may be a barrier for smallscale farmers who may not have the financial resources to invest in these technologies.

X. CONCLUSION

AI has the potential to transform agriculture in India and help address many of the challenges facing the sector. While the use of AI in agriculture is still in its early stages, there is already significant interest and investment in the area, and we can expect to see further developments in the coming years. The Union Budget 2023 has demonstrated the government's commitment to leveraging technology to transform the agricultural sector. The allocation of funds for the eNAM platform, digital soil testing labs and the establishment of a national center for AI research in agriculture are all positive steps in these directions with the right investments in digital infrastructure and capacity building, India can become a leader in AIpowered agriculture and unlock the full potential of its vast agricultural sector

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