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ARTIFICIAL INTELLIGENCE IN AGRICULTURE: ENHANCING YIELD AND SUSTAINABLE FARMING PRACTICES AMONG FARMERS IN INDIA

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ABSTRACT:
Artificial intelligence (AI) is being used efficiently in many fields, including agriculture, around the world. Agriculture plays an important role in the Indian economy, contributing to employing 46 percent of the total population of India and ensuring national food security. Researchers say that the world population will reach 1000 crores by 2050, and for that increased population's basic infrastructure, like roads and houses, will also increase. Some agricultural land will be used to fulfill the basic infrastructural needs of the increased population. To fulfill the food needs of an increased population will be a big challenge in front of all governments in the world. Within limited land, farmers have to produce the needed food for the entire population. Climate change, diseases on the yields are big barrios to good production and productivity in a small amount of land. This paper uses secondary data to examine how artificial intelligence (AI) can enhance agricultural yield and promote sustainable farming practices. In this paper, we review AI tools such as drones, disease detectors, and digital advisory services, and analyze challenges in adopting AI tools and software. This paper concluded with policy recommendations.

Keywords: *Artificial intelligence, agriculture production and productivity, marginal and small farmers, Climate change, Yield.*

INTRODUCTION:

India is an agrarian country with a large agricultural economy. According to the Periodic Labor Force Survey (PLFS) data for 2023-24, around 46.1 percent of India's total workforce was dependent on agriculture and allied activities. This marks an increase of 3.6 percent from 42.5 percent in 2018-19. The total population of villages, 65 percent of the present population, still depends on agriculture and related industries, as well as allied activities. The United Nations Economic and Social World Department report "World Population Prospects" 2024 claims that the world's population will reach 1000 crore by 2050. To create living facilities, such as infrastructure and houses for such a huge population, a large amount of land will be used, resulting in a reduction of agricultural land. Producing food for this huge population will be a challenge. To provide food for the huge population in the world, increasing agricultural land will not be possible; therefore, we will have to adopt new technologies to increase agricultural production and productivity. However, when using these new technologies in agriculture, farmers face many problems, such as small land holdings, a shortage of agricultural labor, low capital, climate change, environmental issues, and soil fertility. To overcome these problems, farmers must adopt artificial intelligence. In other countries, such as China, Japan, and England, artificial intelligence is used in agriculture, which performs all the work from cultivation to harvest. This study examines the role of artificial intelligence in improving agricultural productivity and sustainable agriculture in India using secondary data from authentic resources. This paper reviews the existing literature, analyzes the current trends in AI adoption among farmers, discusses the challenges, and concludes with policy recommendations for better adoption of artificial intelligence among farmers.

Objectives:

1) To explore the use of AI in improving yield and sustainability in Indian agriculture.
2) To identify barriers to the adoption of AI
3) To provide policy recommendations for farmers in India regarding AI.

RESEARCH METHODOLOGY:

The present study only considered secondary data. In this study, literature related to the research has been explored, such as government data, the Economic Survey of India, government reports, websites, research papers, etc. All published and unpublished resources have been used.

AI IN AGRICULTURE: ENHANCING YIELD AND SUSTAINABILITY

In the era of technologies, Artificial Intelligence (AI) is transforming all sectors, including agriculture, worldwide. Government initiatives, research institutions, and agritech industries are actively improving and working on AI tools to help all farmers get higher yields with minimum cost and more sustainable practices.

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1) **Smart Agriculture**: With the help of AI, precision agriculture is possible by combining real-time data from soil, satellite images, drone images, and weather forecasts. All these inputs will be analyzed by a machine learning algorithm to help farmers make accurate decisions about all the activities farmers do in agriculture. Ex. After examining the soil, how much and what kind of fertilizers the particular crop and soil need, or how much water the crop needs, fertilizers, water, and other needed things will be given to the crop according to the results obtained from the soil examination. Because of this, production and productivity per hectare will increase. The cost of production will decrease. Wastage of water and fertilizer will be minimized, and the most important agriculture will become more sustainable. In India, the Maharashtra government approved a special AI agriculture policy with a 500 crore outlay (2025-29) to build data-driven farming infrastructure and promote precision AI tools across the state.

2) **Early Disease Detection:** Crop disease or symptoms are not easily visible to the human eye, but due to the AI revolution, identifying crop problems, AI-driven disease detection has become a crucial tool for minimizing yield loss. An **IIIT Allahabad researcher developed an AI tool (CVGG-16)** with the help of leaf images and sensor inputs such as soil moisture, temperature, and humidity, which can detect early crop diseases. This tool has been used for crops like maize and potatoes. The report says that the model has 93-97 percent accuracy for detecting early crop diseases. With the help of AI devices, crop diseases can be detected more quickly than traditional techniques, which saves money for farmers and prevents crops from being destroyed.

3) **Advice and market Information:** According to the Agriculture census 2015-16 says that among the total farmers, 86 percent are marginal and small farmers. Taking advice regarding yield diseases or the market platforms is costly for these farmers, but AI advisory tools are reducing the knowledge gap for Indian farmers without costly agronomist experts in the field. AI apps and chatbots provide real-time guidance about local weather, water management, fertilizers, pests, and market price information. Ex. In Telangala, for project Sagu Bagu WhatsApp bot assisted farmers in the local language about crop care, such as pest control and water scheduling for a particular crop.

4) **Utilization of resources :** AI helps farmers reduce their costs by providing accurate guidance for the crop regarding fertilizers, pesticides, and irrigation schedules after monitoring soil health. With the help of AI efficiency, farmers can reduce waste and soil pollution. This efficiency leads to sustainable farming practices and reduced chemical use, so soil and groundwater will be clean.

CHALLENGES IN AI ADOPTION IN AGRICULTURE:

Research is required in any field to use technology. In the future, like other countries worldwide, AI will be used in the Indian agriculture sector on a large scale, but in India socio-economic condition of all the farmers is not good, so India will have to face some challenges in the adoption of AI technologies in the agriculture sector.

1) **Rural digital connectivity Gaps:** According to the 2011 Census of India, from the total population of India, about 68.8 percent population lives in rural India, and from that population, around 59-60 percent population is engaged in agriculture and allied sectors. For real-time guidance from AI tools, farmers need to have good internet connectivity, and a significant number of villages still suffer from poor or no internet facilities. Due to Inconsistence electricity supply in many villages, digital devices and sensors related to AI will not work properly. This infrastructure gap builds a digital divide, which is the major challenge in AI adoption in Agriculture.

2) **Heavy initial capital investment:** Over 86 percent of farmers are marginal and small farmers in India. Even with the subsidies or schemes from the government, such high expenditure for the use of AI tools is beyond the financial reach of most farmers. AI adoption consists of drones, smartphones, expensive hardware, and software, and its basic tools will cost thousands of rupees because of this expensive investment; many farmers either delay adoption or avoid it altogether.

3) **Lack of digital literacy and skill:** Studies show that only 25 percent of Indian farmers are comfortable using digital tools like smartphones, the internet, and agriculture-related apps. The World Bank survey 2022 reported that around 23.4 percent of adult rural Indians have basic digital literacy. Due to a lack of digital literacy, a lack of training, and limited exposure to the particular technologies, they sometimes can not interpret the given solution by AI tools.

4) **Needs for localized AI Solutions:** India is a highly diverse country with different socio-cultural farming practices, cropping patterns, and varied agro-climate zones. Solutions for particular problems will vary from area to area. The weather in Maharashtra and in Punjab will be different, so the solution farmers will get for

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their problems should not be universal, and for this, AI tools need to be localized. So our less literate farmers will get their solutions in the local language with local solutions according to the farmers' needs. The limited access to the AI platforms, unaffordable AI tools for farmers like marginal and small farmers, lack of skill and digital literacy will lead to a reduction in effective use of AI. AI needs to be localized for language and advice related to the local weather rather than global advice.

POLICY RECOMMENDATION:

To overcome barrios regarding Artificial intelligence in agriculture, below are key recommendations.

1) **Expansion of rural power infrastructure and the internet:** AI-based agriculture tools depend on internet connectivity and electricity. However, more than half of the rural areas in India face problems regarding internet and electricity. Expansion of the internet and electricity is a must for the use of AI in the agriculture sector. The Indian government has announced that by June 2026, every village in India will have 4G connectivity, also they are upgrading and decentralizing renewable energy.
2) **Provide subsidies or cost-sharing schemes:** In India farmers 86 percent of farmers are marginal and small farmers. Who cannot afford these AI tools, like drones and soil sensors. The government should provide subsidies or cost-sharing schemes that will reduce individual investment burden for farmers.
3) **Training for digital literacy programs:** Even when AI tools are available for farmers at an affordable cost but digital literacy and skill gap will play a vital role in the effective use of artificial intelligence in agriculture. Many farmers lack experience with agriculture apps and handling smartphones. Krishi Vighyan Kendra and the state agriculture department should provide training programs for farmers. Ex. In Uttar Pradesh, training has been given to large-scale farmers for improving digital skills. Training material and apps available in the local language will improve the reach and use of AI in agriculture.
4) **Encourage Public-Private partnership (PPPs) :** Partnership between AI startups and a research institute can make region-specific AI tools, like soil analysis, early pest detection, and crop forecasting. Which will be more beneficial to the farmers?

CONCLUSION :

The Periodic Labor Force Survey (PLFS) data for 2023-24, around 46.1 percent of India's total workforce was dependent on agriculture and allied activities, underestimating its important role in sustainable rural livelihood. There is around 3-4 percent annual growth in agricultural output despite climatic uncertainty. There a wide inter-regional disparities in productivity, ground-level water, and soil health are the main challenges. With the AI technology tools, farmers can detect many yield diseases before time and farmers can use appropriate pesticides to prevent those diseases. Several pilot study says that with the perfect help of AI, yields can be increased by 20-30 percent while reducing inputs, leading to a sustainable environment. These gains are dependent on addressing key structural constaints-notable gaps in digital infrastructure, digital literacy, and a lack of digital skills, and high initial technology cost. Therefore, AI adoption by all the farmers in India will need to be supported by public investment, affordable and easy access models, and capacity building.

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