

Use of AI in Agriculture Sector and Developing Economy

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Abstract

IoT and AI are now overtaking the industry, right from healthcare to smart solutions. Analytical applications are making their way into almost all areas of the industry, right down to the agricultural sector. There are so many issues facing researchers in agriculture – soil, pests, irrigation, post-harvest management, farmers' ignorance, new technologies. AI can help to solve these problems. [1]

The power of Artificial Intelligence (AI) has become the future of farming by solving decades-old productivity, resource and sustainability issues. In emerging countries where agriculture forms the backbone of economic development and food security, AI technologies are at the center. This essay explains how AI can be used in agriculture, the advantages and disadvantages for developing countries, and how it could transform farming. The book also looks at examples, technology and policy considerations to identify opportunities to apply AI in agriculture for a better future.

Keyword: AI, Agriculture, Developing Economy

Introduction

The agriculture industry is very important in many nations especially emerging economies and developing nations. In line with this technological growth, Artificial Intelligence is one such technology that is being used in the agriculture sector and has wide-ranging applications and solutions for both the farmers and government. In this paper, I will describe AI usage in agriculture and its applications to emerging economies. The food we eat is the main source of income for many people in developing nations, and the leading source of GDP and jobs. Yet productivity, climate change, lack of resources and lack of technology are all longstanding issues in the sector. Machine learning (ML), computer vision, robotics, and IoT integration are among AI technologies that can be deployed to boost farm productivity, use efficiency, and climate resilience.

Methodology

This research paper employed a comprehensive literature review to investigate the current state of AI integration in the agricultural sector of developing economies. The review focused on examining the key opportunities, challenges, and policy recommendations surrounding the implementation of AI-based technologies in the agricultural domain.

Data was collected from various academic databases, including Scopus, Web of Science, and Google Scholar, using a combination of keywords such as "AI in agriculture", "precision farming", "developing

economies", and "sustainable agriculture". The selected sources covered a range of disciplines, including computer science, agricultural science, and development economics, to provide a holistic understanding of the topic.

Technological Advancements in Agriculture

Artificial Intelligence (AI) based technologies in agriculture has revolutionized agriculture and has helped farmers improve every single facet of their business [2]. These technologies involve sensors and robots for precision agriculture: automated irrigation, targeted pest control, resource planning. Furthermore, with the advent of predictive analytics and machine learning algorithms, we are now capable of making better decisions for yields, pest management, and farm efficiency. [3][4] [2] Artificial Intelligence in Agriculture Has Revamped the Farming Industry. It is the technology that saved the yield of crop from a lot of problems like climate change, population increase, job losses, and the food insecurity. AI has been evident in agriculture as scholars and scientists have already started to adopt new IoT technologies in smart agriculture for farmers' use of AI in designing better seeds, crop protections and fertilizers. It will increase the profits of farmers and national economy.

Impact on Developing Economies

Implementing AI in the agriculture industry of emerging economies can open many doors. : Farmers in these areas are typically faced with inadequacy of information, knowledge and statistics about the best farming conditions, for example timely and accurate weather forecast, pest management, market needs etc. Farmers can be better informed, better able to handle risks, make operations more efficient, and less expensive thanks to AI-powered technologies.

Though AI could benefit agriculture in all kinds of ways, it still faces a number of hurdles to be overcome in order for it to be used extensively in developing countries. The high upfront investment cost, digital infrastructure and connectivity, digital literacy of the farmers and the necessity for customized AI to the needs and realities of the specific region are some of these issues. And there is the matter of data privacy and security as well as ethical issues around using AI in agriculture, which need to be addressed to make these technologies useable responsibly and fairly.

How to use AI in increasing agriculture productivity in developing economy

AI will transform agriculture in developing countries by solving different problems and increase productivity. Precision agriculture is one of the main areas where AI can be used. Artificial Intelligence-powered sensors and drones can extract data on soil moisture, nutrients, crop health, and the weather in real time so that farmers could make the appropriate resource allocation, irrigation, and pest control decisions [2] [5] [6]. It can result in higher yields, lower input costs and overall farm productivity. Predictive analytics is another area where AI can be of value. A combination of historical information and weather can give farmers a prediction of yields, pest outbreaks and market demand [5] [4]. The data can be used by farmers to schedule planting and harvesting, improve supply chain management, and take informed actions that will increase their profits. Computer vision and deep learning are already finding their way into agricultural robotics to do the weeding, spraying and harvesting. [5] [4] [3] [6]

Such AI-powered robots can be made more productive, less labor intensive and produce a better crop. Even with all the good things about AI in agriculture, there are a few obstacles that have to be overcome for AI to be effective in developing economies. It's also the lack of digital infrastructure and connectivity in the countryside which might be a barrier to the use and adoption of AI-based solutions. Additionally, the expensive up-front cost of AI can be prohibitive for poor farmers. These issues require governments and policymakers in emerging economies to invest in developing nations' digital infrastructure, financing and incentives for farmers to leverage AI technologies, and introducing digital literacy and training programs to empower farmers.

Crop Monitoring and Yield Prediction

AI in crop monitoring and yield forecasting can do wonders for developing nations. Smart sensors and drones can collect real-time information about soil moisture, nutrients, crop status, and environmental conditions so farmers can take decision-making over resources, irrigation and pests. [5] [3] Such technologies can increase yields, cut inputs, and generally make farms more efficient. [4] for instance mentions how AI-based technology could inform farmers in emerging economies on optimal production conditions – weather forecast, pest and market data, etc – so they can take risks and optimise their operations.

Predictive analytics and machine learning algorithms are also being used by scientists to forecast yields of crops from historical records and the weather.

Such data can be used by farmers to predict planting and harvest times, manage the supply chain and make better choices to maximize their profits [3] [4] [5].

Agricultural Robotics and Automation

Newer technologies such as computer vision and deep learning are also used in agriculture robotics to automate harvesting, weeding, spraying and other tasks.

These intelligent robots could produce more work, cheaper labor and produce a higher-quality crop. For example, how AI-based tools could support farmers in managing market disequilibrium in regional and global value chains by suggesting how they should manage risk, increase efficiency, and plan planting and harvest times according to the market.

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Soil Health ,Fertilizer Management, Pest and Disease Management

AI can also help to keep soils healthy and make fertilizer better managed in the developing world. AI algorithms can analyze soil data to give farmers suggestions on what types of fertilizers to apply, how much and when to apply it to increase fertility and nutrient uptake. That can mean higher crop yields,

lower input prices and more environmentally sustainable agriculture. AI-based robotics and automation, called precision agriculture, have the potential to revolutionize productivity and resource use in developing countries. Drones and robots on the ground are self-propelled for precision spraying, selective weed control and automated harvesting. This can decrease labor prices, speed processes, and yield the quality of food. AI-based systems can also be utilized for early detection and management of pests and diseases in crops. By analyzing data from sensors, satellite imagery, and historical records, AI algorithms can identify potential pest outbreaks and provide farmers with timely warnings and recommendations for targeted intervention. This can help reduce crop losses, minimize the use of pesticides, and improve overall farm productivity.

Identifying the right crop using AI

It can also be used to select for the ideal varieties of crops for a given soil type in low-income countries. AI algorithms can use information on soil properties, weather conditions and market trends to advise farmers about what crops to grow for the best odds of success and profitability. All in all, there's great potential for developing economies with the adoption of AI in agriculture. If governments and policymakers solve infrastructure and digital literacy barriers and increase use of AI technologies, then this lifesaving technology could be unleashed and produce sustainable agricultural development.

Benefits of AI in Agriculture for Developing Economies

The integration of AI in the agricultural sector can bring about several benefits for developing economies:

- **Improved Crop Yields and Productivity:** AI-powered technologies can enhance crop monitoring, yield prediction, and smart irrigation, leading to increased agricultural productivity and better resource utilization.
- **Enhanced Pest and Disease Management:** AI-based systems can provide early detection and targeted intervention for pests and diseases, reducing crop losses and minimizing the use of harmful pesticides.
- **Optimized Resource Allocation:** AI can be used to optimize the application of inputs like water, fertilizers, and pesticides, leading to cost savings and more sustainable farming practices.
- **Increased Market Access and Efficiency:** AI-powered technologies can help farmers overcome market asymmetries, improve supply chain management, and better align production with market demands.
- **Reduced Labor Costs:** Automation and robotics enabled by AI can decrease labor requirements and increase efficiency in agricultural operations [3] [5] [4] [6].

Challenges in Implementing AI in Agriculture

For all the obvious advantages, implementing AI in the agriculture of developing countries poses some difficulties:

1. Access and Quality of Data: Obtaining accurate and up-to-date data on crop, soil and weather conditions is a real pain in most of the developing countries.
2. Technical Infrastructure: A lack of digital infrastructure, internet connectivity and computing power can hamper the implementation and scaling of AI solutions.
3. Lack of Technical Expertise and Digital Education: Lack of technical knowledge and digital education among farmers prevents them from using and applying AI-enabled devices efficiently.
4. Regulatory and Policy Environments: The creation of the right regulatory and policy environment for responsible and equitable AI adoption in agriculture is important but, in some places, difficult.
5. Cost Factors: Initial capital investment for AI technologies can be a major obstacle for smallholder farmers and resource-constrained farmers.

This must be solved by collaboration between governments, scientists and agricultural players to make AI successful in the agricultural sector of emerging countries.

Hello Tractor – Case study

One successful example of AI integration in the agricultural sector of a developing economy is the Hello Tractor initiative in Kenya.

Hello Tractor is a digital platform that connects tractor owners with smallholder farmers in need of tractor services.

Using AI-powered algorithms, the platform matches tractor availability with farmer demand, optimizing the utilization of tractor resources and improving access to mechanization services for smallholder farmers [5].

The platform also collects data on tractor usage, crop yields, and other farming activities, which is then analyzed using AI to provide farmers with insights and recommendations on improving their farming practices.

This has led to increased yields, reduced input costs, and more sustainable farming practices for smallholder farmers in Kenya, demonstrating the potential of AI-driven solutions in addressing the unique challenges faced by developing economies.

Policy Recommendations

In order to make full use of AI in the farming sector of developing economies, there are several policy proposals that might be helpful:

Build Digital Infrastructure: Governments should prioritize the development of robust digital infrastructure, including high-speed internet connectivity and access to computing resources, to enable the widespread deployment of AI-based technologies.

Support Digital Literacy and Capacity-building: Education and training programs should be focused on digital literacy and technical competencies among farmers and stakeholders in agriculture so that the AI – driven technologies can be easily adopted and used effectively.

Ensure there are appropriate regulatory mechanisms: Policies need to come up with detailed regulatory policies for ethical and responsible use of AI in agriculture including data privacy, algorithmic bias and environmental responsibility.

Financial Incentives: Governments could provide financial incentives (eg, subsidy or low-interest loans) to make AI technologies affordable for smallholder farmers and farmers.

Conclusion

Bottom line: Artificial intelligence can be incorporated into developing countries' agriculture, greatly enhancing productivity, exploitation of resources and profitability. But achieving this promise will require multistakeholder participation: between governments, scientists and farmers. Policy recommendations include Investing in Digital infrastructure, Digital literacy and capacity building, Regulation, and Offering Financial Incentives to make AI accessible.

Developing economies can take up the challenge and seize the potential of AI and deliver a sustainable and equitable agricultural future. From the literature review, we can conclude that if AI is used effectively in developing countries' agriculture, then resource efficiency, yield, and climate resilience could all be enhanced. [4]

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