

AI in Agriculture: Opportunities, Challenges, and Recommendations

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Artificial Intelligence (AI) is rapidly being integrated into people's lives, reshaping industries, and enabling previously unimagined innovation, even in agriculture. Generative AI focuses on creating content like text and pictures based on vast quantities of data. ExtensionBot is a generative AI platform that supports agricultural extension by providing farmers with accurate scientific information and specific recommendations. It has been shown to deliver more accurate responses to agricultural questions than broader generative AI models. Other forms of AI have been used to analyze data to provide support for management decisions, such as in livestock monitoring, food traceability, genetic studies, and predicting weather and crop yield. Furthermore, AI is particularly adept at image analysis and can identify things like insects, weeds, and diseases. It has also been used to detect the quality of produce and allow for machines to perceive the precise location of fruits for robotic picking.

Many successful examples of AI in agriculture exist, but numerous challenges prevent rapid development. These include the common incompatibility of agricultural data, the wide variability in agriculture that restricts the broad applicability of AI models, the common lack of connectivity in rural and agricultural areas, concerns about the privacy of agricultural data, the resistance to change in the agricultural industry, the lack of an AI-skilled workforce, and high adoption costs for AI technologies. Furthermore, there is fear about how AI will affect the agricultural community's ability to maintain human knowledge and skill in agriculture. Cybersecurity is another concern, particularly as autonomous machines begin to emerge, facilitated by AI. If robots are performing agricultural tasks, what happens when they are hacked or simply fail, and a human is not available to solve the immediate problem? Additionally, the advancement of AI in agriculture affects humans in multiple ways. First, it affects the work that agricultural workers perform and

how that work is done. Ideally, workers will have input into the design of AI tools to ensure these tools improve their efficiency and safety in daily tasks as well as their overall work experience. Consumers of agricultural products also have a stake in AI for agriculture, as it can improve food safety, nutrition, and health. There are also particular ethical concerns about the advancement of AI in agriculture. For example, the aggregation of data among numerous farms can have disadvantages for small and low-income farms. More research is needed to develop AI for agriculture in ways that are mindful of the many challenges.

If resources for research on AI in agriculture are unavailable, innovation will be reduced and collaboration hindered in its development. Researchers may end up competing for tightly limited funds rather than sharing knowledge. For the U.S. to lead the world in developing AI for agriculture, it must promote innovation, industry competition, interdisciplinary collaboration, and appropriate standards to ensure big data and AI are used responsibly and contribute to efficient and resilient agriculture and food systems. We recommend that policymakers focus on AI in agriculture to create an enabling environment for its development, to ensure adequate resources are available for research, to facilitate opportunities for workforce development, to enable guidelines leading to its adoption, to foster a regulatory framework that protects agricultural data, to ensure wide-ranging benefits to various scales and income levels of farms, to provide for cybersecurity, and to promote the development of standards to ensure AI systems in agriculture are safe, efficient, reliable, and ethical. There is immense potential for AI to enable the next step change in agriculture, and initiatives should be formed to position the U.S. as the global leader in agricultural AI, driving economic growth, ensuring food security and food safety, and promoting ethical practices that lead to environmental stewardship.