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Harvesting the benefits of artificial intelligence in agriculture: An ethical approach

Have you ever wondered if robots or unmanned aerial systems (UASs) could assist farmers in monitoring crop plants or eliminating weeds? While, this may have sounded like a science-fiction movie plot half-a-century ago, it is now a reality! As per a United Nations report, the world population is about to reach 9.8 billion by the end of 2050. With this growth rate, it is becoming imperative for farmers to use technologies that are advanced and can automate farming operations to address this *"produce more in less time"* challenge. Artificial intelligence (AI) is one such advanced approach that strives to solve the above challenge. The potential value that could be generated by integrating AI technology in agriculture is estimated to be around $127 billion by 2030 (McKinsey and Company, 2019).

The present era is marked by *"agricultural datafication"* using big data. AI when coupled with big data imparts learning ability to computers via algorithms. These algorithms are capable of achieving tremendous success in the area of crop price forecasting (cost savings), crop yield prediction (enhanced decision-making), and vision-based crop monitoring (assisting with labor shortage). But before AI algorithms can solve any task, human intelligence comes into play right from source data collection to data wrangling and finally feeding into AI algorithms. Therefore, the ethical challenge to integrate AI in agriculture is a concern for researchers and stakeholders alike. As university graduates and industrial technorati enter the new age of understanding and deploying AI-based agricultural research, new ethical guidelines will play a critical role in navigating the moral landscape of AI and its overall implications.

Background

According to a survey, AI-based farming operations will have a predicted market size of over 4 billion USD by 2024 (von See, 2022). This means that almost every industry and university will be integrating AI techniques in several areas including fertilizer recommendation, crop yield prediction, phenotype estimation, disease identification, weed classification, soil health monitoring, smart irrigation, animal production, robotic harvesting, autonomous navigation,

and many more in the future (Singh and Kaur, 2022).

The aforementioned areas would require four fundamental steps, therefore integrating ethical frameworks would encourage purpose-driven work being carried out in order for AI to benefit agriculture:

1. Data acquisition — Adhering to the ethics of data privacy and ownership
2. Data management — Responsibly handling the data
3. Data analysis — Making the AI system explicable for all users
4. Data in action — Guarding the AI system against mishaps and cybersecurity attacks

Small levels of human prejudice that are influenced due to social-ecological causes or preconceived notions in any of these steps will prevent AI from making timely and unbiased decisions, thereby rendering them redundant. Therefore, establishing proper ethical frameworks or policies within these steps will gain the trust of stakeholders, farmers, growers, and agricultural technology providers (ATPs) by making AI technology less ambiguous in terms of providing feasible solutions to the present challenges.

Data acquisition — Adhering to the ethics of data privacy and ownership

> "*Data is like garbage if you don't know what you're going to do with it before collecting it.*" — Mark Twain.

On average, a farm generates 500,000 agricultural data points per day. This number is expected to increase by 800% by 2036 (IBM, 2019). With this increase in the percentage of data collection, suitable measures need to be established in the area of *"data privacy"* and *"accountability."* For example, tech industries that collect data from a farmer's field should sign an agreement document against leaking farm data without consent. They should also be accountable in answering the 3W's; *"what"* (data type), *"when"* (time frame), and *"why"* (purpose). Proper measures should be established concerning data ownership and monetization.

Researchers should also follow a similar ethical framework. For instance, if one graduate researcher is responsible for collecting and testing the data, this may lead to bias in

research outcomes. Therefore, different researchers should acquire test dataset to avoid any bias concerning testing the developed AI algorithms. Regularizing this ethical guideline will also strengthen two areas, 1) collaboration amongst universities or researchers, and 2) better technical advancements in AI-based technologies.

Data management — Responsibly handling the data

> *"Data preparation is 80% of the work done in data science."* — DJ Patil, former Chief Data Scientist of the United States.

AI works on the principle of GIGO (Garbage In Garbage Out). This means that the output model will reflect the quality of data that it has been trained on. A common practice amongst researchers is to gather and train large amounts of data. This is also guided by a common notion, more data leads to more precision. But, this is not the case when the intention is to scale AI technologies in the real world. Therefore, imparting the attributes of *"fairness"* and *"responsibility"* within the training dataset plays a critical role.

For instance, robots built on AI technology have successfully automated the process of milking cows (Bhattacharya, 2021). Although these technologies have been promised to assist farmers, the danger lies in robotic malfunctioning and thereby hurting cows (Stueve Siegel Hanson LLP, 2020), since the real-world situation may fall out-of-scope based on the training dataset fed to the AI algorithms. This also holds true with driverless tractors. Consider, if the AI component responsible for autonomous navigation encounters a situation irrelevant to the training dataset and malfunctions by crashing into a neighbors farm, who would be held responsible? The farmer or AI technology? This would also raise serious questions about liability. Therefore, ethical policies regarding rigorous testing of the system should be established before adopting it for real-world applications.

Data analysis — Making the AI system explicable for all users

> *"An AI model is trained to carry out a specific task, it is largely mysterious how it works."* — From the book, Rebooting AI - Building Artificial Intelligence We Can Trust.

Most AI-centered tools and algorithms are considered black-box techniques and it is usually assumed that their inner workings cannot be easily understood by non-experts. Such assumptions can be deceptive and may lead to less adoption of AI tools by farmers and growers. Additionally, if these tools are commercialized, they may not sustain in the market due to their dubious nature. Therefore, proper ethical policies should be established to provide "behind the scene" information of an AI system.

Moreover, as per the ethics of *"explainability"*, an AI-based system should be transparent by enabling a clear understanding as to how and why it made such decisions. This specifically holds true when dealing with farmers that are concerned regarding the use of novel technologies without relying on external factors such as engineers or experts. *"AI model interpretability"* (Li et al., 2022) is another ethical framework that should be considered within research communities. Research outcomes or in-field technologies that integrate AI as a component should focus on answering three critical questions, (a) what type of representations are being learned by an AI model during the training phase?, (b) how and why is the model learning those representations?, and (c) what could be done to improve the learning capability of these models? Answering these questions will eliminate the dilemma of AI being a black-box technique thus encouraging more *"transparency"* and *"disclosure."*

Data in action — Guarding the AI system against mishaps and cybersecurity attacks

> *"We are surrounded by data, but starved for insights."* — Jay Baer.

Once the above steps are accomplished, a trained AI model is deployed to perform a specific task. These tasks could range from making crop yield predictions to directing a robot to perform harvesting operations. While AI applications in agriculture are diverse, but one ethical framework is supreme, *"beneficence."* Asking the following ethical-based questions could enhance the final outcome of the developed technology. These questions might pertain to sustainability, limitations, issues of digital divide, ensuring right use, and cybersecurity attacks (AgAmerica Lending, 2023).

Additionally, once an AI model is deployed to solve a real world task, metrics concerning

the performance of the system should be evaluated. If the AI system fails or malfunctions, immediate actions must be taken to avoid future fatalities. Overall, the ultimate goal of an AI technology should be to *"minimize risk and maximize profits"* by serving humans.

Conclusion

Every technology ever created and deployed to serve humanity has its downsides and perceived benefits. AI technology is no different! After all, AI is a technology with no self-awareness. For example, while a robot that plucks weeds does not know they are fatal for crop production, humans that created this technology possess this attribute. Therefore, as agricultural and biological engineers who are creators and partakers of this technology, should tend to establish strict boundaries based on ethical and moral frameworks. Constant reviewing and updating the ethics based on future requirements is essential when we ask questions, establish policies, and integrate the same with AI technology, thereby *"democratizing"* AI for the benefit of all concerned.

References

AgAmerica Lending (2023). Protecting your farm against cyber attacks.

Bhattacharya, S. (2021). Robotic milking: A process that is advancing the dairy farms.

IBM, B. (2019). CIO insights: The future of intelligent farming & food supply chain management.

Li, X., Xiong, H., Li, X., Wu, X., Zhang, X., Liu, J., Bian, J., and Dou, D. (2022). Interpretable deep learning: Interpretation, interpretability, trustworthiness, and beyond. *Knowl. Inf. Syst.*, *64*(*12*):3197–3234.

McKinsey and Company (2019). Artificial intelligence and the circular economy: AI as a tool to accelerate the transition.

Singh, P. and Kaur, A. (2022). A systematic review of artificial intelligence in agriculture. *Deep Learning for Sustainable Agriculture*, pages 57–80.

Stueve Siegel Hanson LLP (2020). Robotic milker failure: Lawsuit filed against Lely North America Inc.

von See, A. (2022). Artificial intelligence in agriculture market by farming type worldwide 2019 and 2024.