HUMAN-CENTERED AI IN SMART FARMING: TOWARD AGRICULTURE 5.0

Guided by:
Ms. Resmipriya M G
Assistant Professor
Dept. of CSE

Aadhi Lakshmi M R
S7 CSE A
Roll no:1 (AJC21CS001)
14/08/24

Contents

- *Abstract*
- Introduction
- The Evolution of Agriculture
- Human-Centered AI (HCAI) Concepts
- Evolution of Industry
- Methodology: The Transition to Agriculture 5.0

Contents

- Core Principles of HCAI
- Applications in Smart Farming
- Challenges and Considerations
- Conclusion
- Acknowledgement
- Q&A

1

INTRODUCTION

Challenges in Agriculture:
- Impacts of climate change,
- Rapid population growth,
- Shrinking arable land,
- A rising demand for food, and
- Soil degradation

These have incited dramatic changes in agricultural practice and an urgent need for more efficient resource management.

Technological advancements have involved new tools and methods to somehow respond to these critical issues like,
- precision farming,
- drones,
- IoT and
- AI

They must be linked in a coherent and sustainable system to be truly effective

2

The Evolution of Agriculture

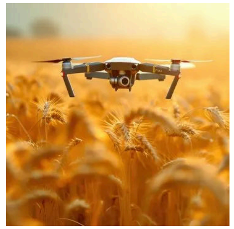
Agriculture 1.0: In pre-industrial times, farming relied heavily on manual labor, animal power, and simple tools. Farming methods were primarily subsistence-based, with minimal technological intervention.

Agriculture 2.0: The advent of mechanization in the late 19th and early 20th centuries tractors, harvesters, and other machinery significantly increased productivity, reducing the reliance on human and animal labour.

3

The Evolution of Agriculture

Agriculture 3.0: The Green Revolution of the mid-20th century introduced chemical fertilizers, pesticides, and high-yield crop varieties. These innovations increased food production but also led to environmental concerns, such as soil degradation and water pollution.



Agriculture 4.0: The digital revolution brought precision farming, characterized by the use of GPS, IoT devices, drones, and big data analytics. These technologies enable farmers to optimize inputs, monitor crops in real-time, and enhance efficiency and productivity

4

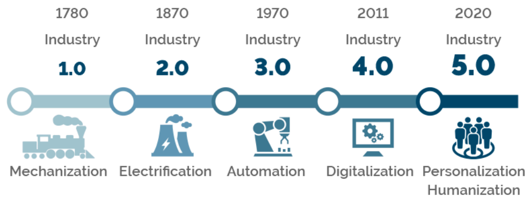
Human-Centered AI in Agriculture

- **Role of Human-Centerd AI**: The orientation of human-centered AI in agriculture is toward the development of artificial intelligence systems that support human decision-making, rather than replacing it.
- **Why Human-Centered?** Agricultural systems are complex, requiring AI that's adaptable and context-aware. HCAI helps farmers navigate trade-offs by providing outputs informed by human values and ethics.
- **Benefits**: AI combined with human expertise enables better farming decisions, improving resource management, climate resilience, and overall productivity.

5

Evolution of Industry

Industry 1.0 introduced water and steam-powered production in the 18th century. **Industry 2.0** brought mass production and electricity in the early 20th century, followed by **Industry 3.0** with automation and computers. **Industry 4.0** connected systems with digital tech and IoT. **Industry 5.0** marks a shift in industrial evolution, where humans collaborate with advanced technologies like AI, robotics, and IoT.



Methodology: The Transition to Agriculture 5.0

Agriculture 5.0 is the next stage in the evolution of farming, where the focus shifts from purely technological innovation to the integration of human-centered AI and sustainability. This new paradigm aims to create a farming ecosystem that is not only efficient but also ethical, resilient, and sustainable.

Human-centered AI + Industry 5.0 = Agriculture 5.0.

- **Human-Centric Focus**: Agriculture 5.0 focuses on enhancing human judgment and values, aiming to augment human capabilities rather than replace them with automation.
- **Industry 5.0 Comparison**: Agriculture 5.0, like Industry 5.0, emphasizes collaboration between AI and human expertise, aligning technology with human needs and goals like sustainability and food security.

Core Principles of HCAI

- **Transparency & Explainability**: AI systems must be clear and understandable to build trust and enable informed decisions by farmers.
- **Empowerment & Augmentation**: AI should enhance farmers' abilities, providing actionable insights to improve decision-making.
- **Ethical Considerations & Fairness**: AI must be fair, unbiased, and respect rights, benefiting all farm sizes while protecting data privacy.

Core Principles of HCAI

- **Adaptability & Flexibility**: AI should adapt to diverse farming environments and meet individual farmers' needs.
- **Safety & Reliability**: AI must be reliable, providing consistent recommendations crucial for food security and sustainability.
- **Continuous Learning & Iteration**: AI should improve over time, learning from new data to stay effective as farming evolves.

Applications in Smart Farming

- **Data-Driven Crop Management**: AI-powered tools analyze vast amounts of data from various sources, including weather forecasts, soil sensors, and satellite imagery, to provide farmers with precise recommendations for planting, watering, fertilizing, and harvesting.

- **Predictive Analytics**: AI models predict future events, such as pest outbreaks, disease spread, or yield potential, allowing farmers to take proactive measures to mitigate risks.

10

Case Studies

Case Study 1: AI in Wheat Farming

- Scenario: A wheat farm in Kansas implemented AI-driven predictive models to optimize planting times, irrigation schedules, and fertilizer applications.
- Outcome: The farm experienced a 15% increase in yield and a 20% reduction in water usage, demonstrating the potential of AI to enhance efficiency and sustainability in crop production.

Case Study 2: AI in Vineyard Management

- Scenario: A vineyard in California used AI-based monitoring systems to detect early signs of grapevine disease. The system analyzed data from drones, soil sensors, and weather stations to identify areas at risk.
- Outcome: Early intervention based on AI recommendations preserved the quality of the harvest, reduced chemical usage, and saved the vineyard significant costs associated with crop loss.

11

Challenges in Implementing AI in Farming

Technical Challenges:

- Black Box Problem: One of the main technical challenges is the "black box" nature of AI, where the decision-making process is difficult to understand. This lack of transparency can lead to mistrust among users.
- Data Quality Issues: AI's effectiveness is highly dependent on the quality of the data it processes. In agriculture, data can be inconsistent and incomplete.

Social and Ethical Challenges:

- Resistance to AI Adoption: Many farmers may be hesitant to adopt AI due to concerns about job displacement and the complexity of the technology.
- Data Privacy and Ownership: AI in agriculture raises questions about who owns the data collected from farms and how it is used. Farmers may be wary of sharing data with AI providers if they feel it could be exploited.

12

Future Prospects of Agriculture 5.0

Emerging Technologies:

- AI-Driven Robotics
- Edge Computing & IoT
- Machine Learning Advancements

Sustainability Focus:

- Precision Agriculture
- Climate Resilience

13

Conclusion

Summary of Key Points:

- Human-Centered AI as the Key to Agriculture 5.0: By focusing on human-centered AI, we can unlock the full potential of smart farming technologies, creating a more sustainable, resilient, and ethical agricultural system.
- The Balance Between Technology and Humanity: Agriculture 5.0 emphasizes the importance of balancing technological advancements with human values, ensuring that AI enhances rather than replaces human decision-making.

As we move toward Agriculture 5.0, continuous innovation, ethical considerations, and a commitment to sustainability will be crucial in shaping the future of farming.

References

1. X. Xu, Y. Lu, B. Vogel-Heuser, and L. Wang, "*Industry 4.0 and Industry 5.0—Inception, conception and perception,*" J. Manuf. Syst., vol. 61, pp. 530–535, Oct. 2021.X. Xu, Y. Lu, B. Vogel-Heuser, and L. Wang, "*Industry 4.0 and Industry 5.0—Inception, conception and perception*," J. Manuf. Syst., vol. 61, pp. 530–535, Oct. 2021.
2. K. R. Maddikunta, Q.-V. Pham, P. B, N. Deepa, K. Dev, T. R. Gadekallu, R. Ruby, and M. Liyanage, "*Industry 5.0: A survey on enabling technologies and potential applications*," J. Ind. Inf. Integr., vol. 26, Mar. 2022, Art. no. 100257.
3. B.Shneiderman, "*Human-centered artificial intelligence: Reliable, safe & trustworthy*," Int. J. Human–Computer Interact., vol. 36, no. 6, pp. 495–504, Apr. 2020.
4. B.Shneiderman, Human-Centered AI. London, U.K.: Oxford Univ. Press, 2022.
5. S.Polymeni, S. Plastras, D. N. Skoutas, G. Kormentzas, and C. Skianis, "*The impact of 6G-IoT technologies on the development of Agriculture 5.0: A review*," Electronics, vol. 12, no. 12, p. 2651, Jun. 2023.

Acknowledgement

I would like to express my heartfelt appreciation to my teachers, whose guidance and support have been the cornerstone of this project. Your dedication to nurturing our intellectual growth and your willingness to share your extensive knowledge have been truly inspiring.

I would also like to extend a special thanks to my fellow students. Your role as a thoughtful and engaged audience has been invaluable.

Q&A

THANK YOU